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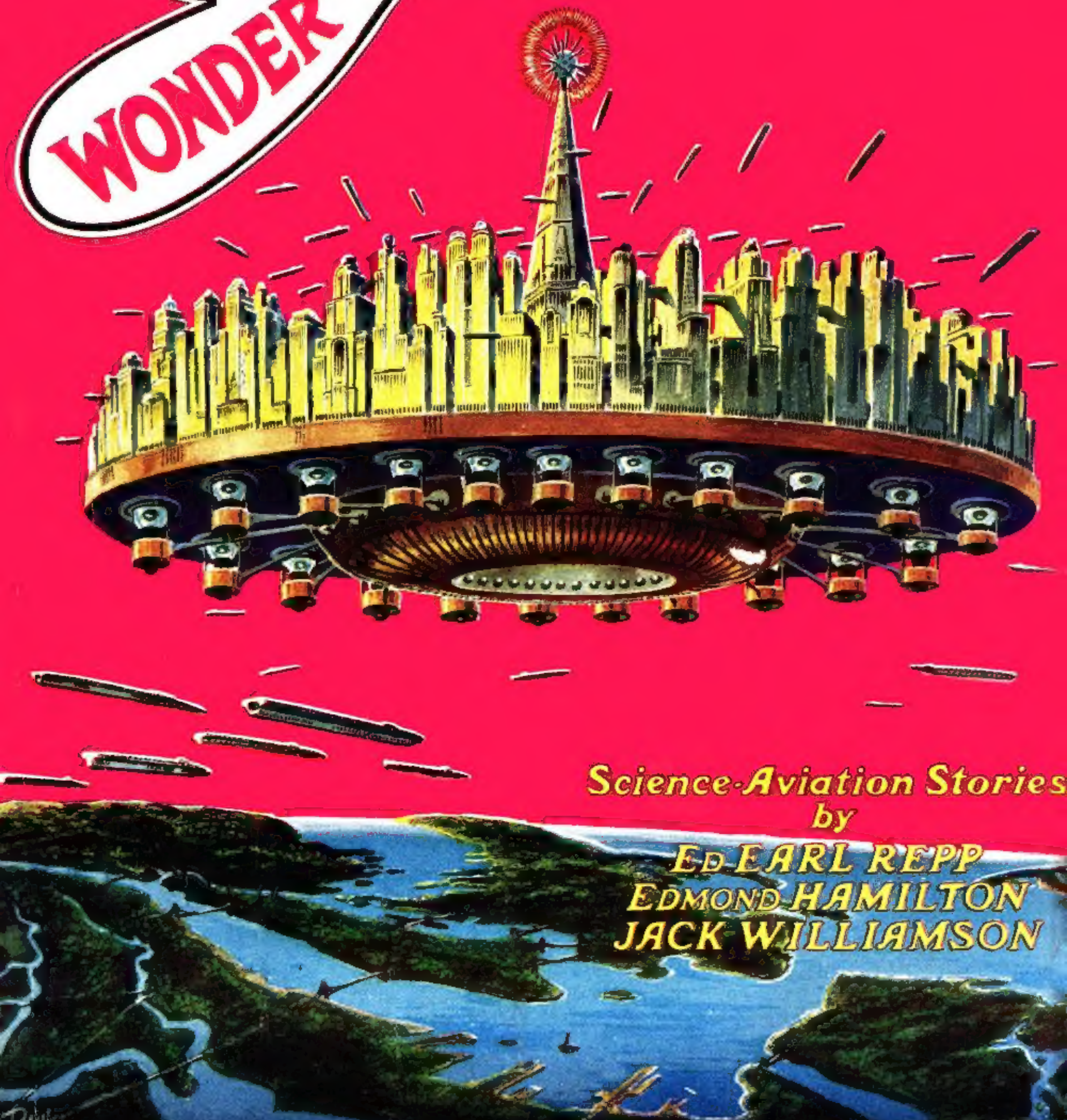
HUGO GERNSBACK
Editor



Science-Aviation Stories
by
ED EARL REPP
EDMOND HAMILTON
JACK WILLIAMSON

Grandfather Walked— **Father Motored—**

YOU WILL FLY!

If the sound of ROARING motors, or the very thought of racing thru the sky makes you "tingle" with joy, then you are among the lucky ones for whom Fame and Fortune await!

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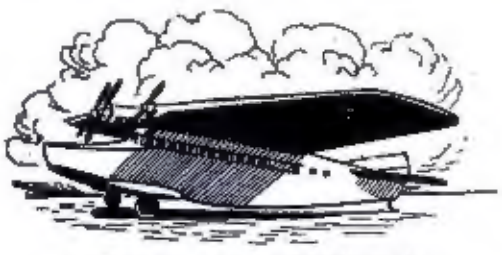
These things will soon become realities. THEN . . . Pilots and Mechanics will vie for Supremacy!

SKILL WILL COUNT!

The best trained men will lead the field. They will hold the most important and highest-salaried positions in the Aviation industry. Those of lesser qualifications will take their pick of the "leavings," while the Cream of the Crop will go as just rewards to the men who were willing to PREPARE—men who were not afraid to make a sacrifice for the sake of their future—men who will thoroughly understand the HOW and WHY of Aviation!



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"What? Learn Music by Mail?" *they laughed*

"Yes," I cried, *"and I'll bet money I can do it!"*

IT all started one day after lunch. The office crowd was in the recreation-room, smoking and talking, while I thumbed through a magazine.

"Why so quiet, Joe?" some one called to me.

"Just reading an ad," I replied, "all about a new way to learn music by mail. Says here any one can learn to play in a few months at home, without a teacher. Sounds easy, the way they tell about it."

"Ha, ha," laughed Fred Lawrence, "do you suppose they would say it was *hard?*"

"Perhaps not," I came back, a bit peeved, "but it sounds so reasonable I thought I'd write them for their booklet."

Well, maybe I didn't get a razzing then! Finally Fred Lawrence sneered: "Why it's absurd. The poor fellow *really* believes he can learn music by mail!"

To this day I don't know what made me come back at him. Perhaps it was because I *really was* ambitious to learn to play the piano. Anyhow, before I knew it I'd cried, "Yes, and I'll bet money I can do it." But the crowd only laughed harder than ever.

Suppose I Was Wrong—

As I walked upstairs to my desk I began to regret my haste. Suppose that music course wasn't what the ad said. Suppose it was too difficult for me. And how did I know I had even the least bit of talent to help me out. If I fell down, the boys in the office would have the laugh on me for life. But just as I was beginning to weaken, my lifelong ambition to play and my real love of music came to the rescue. And I decided to go through with the whole thing.

During the few months that followed, Fred Lawrence never missed a chance to give me a sly dig about my bet. And the boys always got a good laugh, too. But I never said a word. I was waiting patiently for a chance to get the *last* laugh *myself*.

My Chance Arrives

Things began coming my way during the office outing at Pine Grove. After lunch it rained, and we all sat around inside looking at each other. Suddenly some one spied a piano in the corner. "Who can play?" every one began asking. Naturally, Fred Lawrence saw a fine chance to have some fun at my expense, and he got right up.

"Ladies and gentlemen," he began, "our friend Joe, the music master, has consented to give us a recital."

That gave the boys a good laugh. And some of them got on either side of me and with mock dignity started to escort me to the piano. I could hear a girl say, "Oh, let the poor fellow alone; can't you see he's mortified to death?"

The Last Laugh

I smiled to myself. This was certainly a wonderful setting for my little surprise party. Assuming a scared look, I stumbled over to the piano while the crowd tittered.

"Play 'The Varsity Drag'," shouted Fred, thinking to embarrass me further.

I began fingering the keys and then . . . with a wonderful feeling of cool confidence . . . I broke right into the very selection that Fred asked for. There was a sudden hush in the room as I made that old piano talk. But in a few minutes I heard a fellow jump to his feet and shout, "Believe me, the boy is *there!* Let's dance!"

Table and chairs were pushed aside, and soon the whole crowd was shuffling around having a whale of a time. Nobody would hear of my stopping, least of all the four fellows who were singing in harmony right at my elbow. So I played one peppy selection after another until I finished with "Crazy Rhythm" and the crowd stopped dancing and singing to applaud me. As I turned around to thank them, there was Fred holding a ten-spot right under my nose.

"Folks," he said, addressing the crowd again, "I want to apologize publicly to Joe. I bet him he couldn't learn to play by mail, and believe me, he sure deserves to win the money!"

"Learn to play *by mail!*" exclaimed a dozen people. "That sounds impossible! Tell us how you did it!"

I was only too glad to tell them how I'd always wanted to play but couldn't afford a teacher, and couldn't think of spending years in practice. I described how I had read the U. S. School of Music ad, and how Fred bet me I couldn't learn to play by mail.

"Folks," I continued, "it was the biggest surprise of my life when I got the first lesson. It was fun right from the start, everything as simple as A-B-C. There were no scales or tiresome exercises. And all it required was part of my spare time. In a short time I was playing *jazz*, classical pieces, and in fact, anything I wanted. Believe me, that certainly was a profitable bet I made with Fred."

Play Any Instrument

You, too can now *teach yourself* to be an accomplished musician—right at home—in half the usual time. You can't go wrong with this simple new method which has already shown over half a million people how to play their favorite instruments *by note*. Forget that old-fashioned idea that you need special "talent." Just read the list of instruments in the panel, decide which one you want to play and the U. S. School will do the rest. And bear in mind no matter which instrument you choose, the cost *in each case* will be the same—averaging just a few cents a day. No matter whether you are a mere beginner or already a good performer, you will be interested in learning about this new and wonderful method.

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If you are in earnest about wanting to play your favorite instrument—if you really want to gain happiness and increase your popularity—send at once for the Free Booklet and Free Demonstration Lesson which explains this remarkable method. The booklet will also tell you all about the amazing new *Automatic Finger Control*. No cost—no obligation. Sign and send the convenient coupon now. Instruments supplied when needed, cash or credit. U. S. School of Music, 5011 Brunswick Bldg., N. Y. C.

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.....Instr.? .....

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Address .....

City .....State.....

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On the Cover This Month

is illustrated Edmond Hamilton's wonderful story CITIES IN THE AIR. Here we see the future air city of New York suspended high in the air kept aloft by the cosmic rays and made mobile by the mysterious propeller tubes. The city can rise above storms and, if necessary, above clouds to escape rains and snow. In the center we see the electrostatic tower which gathers the energy for the city's operation.

NEXT MONTH

THE FLIGHT OF THE EASTERN STAR, by Ed Earl Repp. A story of the year 2000. Mr. Repp's star continues to rise in his latest offering of aviation fiction. He has looked into the future of air transportation very deeply, and out of it he evolved this most thrilling adventure. Finely conceived science, human adventures and thrilling climaxes race side by side in this startling story. To those of you who remember the thrilling rescues of ships at sea that featured the newspapers not long ago there will be offered in THE FLIGHT OF THE EASTERN STAR a still more thrilling parallel.

FREEDOM OF THE SKIES, by Edsel Newton. At present the highways of the sky are free from many of the limitations that are associated with the land and the sea, but as air travel increases and becomes more and more a part of every day life this may not be true. There will undoubtedly come pirates of the air just as there have been pirates of the sea and highwaymen on land. Attempts undoubtedly will be made to control the air for selfish purposes, and, when this comes, the forces on the side of liberty will wage a great fight against the pirates. In this astounding adventure, Mr. Newton takes us into the future of air travel and gives us a swift moving story.

THE PHANTOM OF GALON, by J. W. Ruff. This story will serve to introduce the talent of one of our new writers. Strange things happen in the story when great nations find themselves at the mercy of a man possessed of uncommon scientific power. Many new instrumentalities of science and thrilling incidents are used by Mr. Ruff to weave them together into a masterpiece of aviation fiction. The action of the story becomes more and more intense and then it ends suddenly with a revelation that leaves us breathless. We are sure you will all agree with us that Mr. Ruff is one of the most promising of our new authors.

CITIES IN THE AIR, by Edmond Hamilton. This marvelous story of the future comes in this issue, to its startling culmination. The whole world shakes with war with vast aggregations of Powers massing their forces against each other in a death grip. You will get in this concluding instalment the most marvelous prophetic pictures of the future. It is in short a most startling conception that you must not miss.

AND OTHERS

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Are You Caught Behind the Bars of a "Small-Time" Job?

Why be satisfied with a "small-time" job at low pay? Why grind along at tiresome, uninteresting work with long hours and no future? Why take orders all your life from every Tom, Dick, and Harry who happens to be your boss?

Right now—this very minute—you hold the key to REAL SUCCESS in your hand. Hundreds of other men before you have read of COYNE just as you are doing now—and are making $60—$75—$150 a week as a result. This is your BIG CHANCE to get friendly help and practical training that will enable you to climb out of the rut, and EARN REAL MONEY! Don't miss it! Today may be the big turning-point in your whole life!

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Without Books or Correspondence
IN 12 WEEKS
By Actual Work—in the Great Shops of Coyne

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Fascinating Work—Real Pay!

That's why so many men are turning to ELECTRICITY, which offers unlimited rewards and opportunities—with ordinary salaries of $60—$75 and up a week! Right now big electrical jobs are actually going begging! Electrical experts are in demand—and the need is growing every day! The situation is one that spells O-P-P-O-R-T-U-N-I-T-Y in letters a foot high for the man who is wide-awake enough to see it!

Learn Quickly

Let me make you a master electrician—the Coyne way. I've done it for thousands of others—farmers, laborers, factory men, and hundreds who haven't had more than 8th grade education! I can do it for you—and start you off on the road to independence and big earnings in just 90 days!

Not by Books

The secret of Coyne-training is that it is ALL PRACTICAL work. No books—no dry lessons—no useless theory. In the great shops of COYNE you learn the "ins and outs" of Electricity by actual work on *real* electrical equipment—the finest outlay in the country! And best of all—experts work right with you every step of the way, showing you all the electrical secrets that are essential to your success!

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are common in electricity. Our free employment bureau puts you in touch with openings to choose from. The following are only a few of the kind of positions you fit yourself for in the Great Shops of Coyne:

Farm Lighting Experts	$60 to $200 a Week
Armature Expert	$60 to $100 a Week
Power House Operator	$50 to $75 a Week
Auto Electrician	$60 a Week and up
Inventor	Unlimited Income
Maintenance Engineer	$60 a Week and up
Service Station Owner	up to $200 a Week
Radio Expert, $60 a Week and up	
Contractor, $5,500 to $15,000 a Year	

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NOW—For a short time I am making a Special 30th Anniversary Offer. You can now get a real money-making training at the lowest price.

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With a personal, *practical* method like this, is it any wonder I say I can make any man into a master electrician in 12 happy weeks? You don't need a bit of previous experience or advanced education. Many of our most successful graduates are fellows who never went to high school and hated "book learning." The Coyne method is *different!*

Special Offer Now

Make up your mind today to get into one of these real-pay electrical jobs. If you act *now*—I'll pay your railroad fare to Chicago and give you these courses free! AVIATION ELECTRICITY, RADIO and AUTOMOTIVE ELECTRICITY! And besides that, I help you to a part-time job while learning! FREE employment service for life after graduation, too. We place dozens of men in wonderful jobs every week.

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VOLUME 1
No. 5

AIR WONDER • STORIES

NOVEMBER
1929

The Future of Aviation Springs from the Imagination

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These aeronautical experts pass upon the scientific principles of all stories

Airplanes MUST Have Radio

By HUGO GERNSBACK

THE recent loss of the transcontinental airplane *City of San Francisco* demonstrates how far commercial aviation lags behind scientific advancement. So far as we can learn, none of our transcontinental air lines use complete radio sending and receiving sets as standard equipment on their passenger planes.

There is, of course, nothing novel about radio equipment on airplanes; because it has long proved successful whenever installed on aircraft. For some reason, however (based mainly on the extra weight which is thereby necessitated) the air-transport companies are reluctant to carry a radio operator and his apparatus. There is, however, no valid reason why automatic or semi-automatic radio equipment should not be installed on every passenger plane.

When radio was young, it was speedily recognized by the authorities everywhere as being essential to the safety of ships at seas; and laws were passed making it compulsory for all passenger vessels to carry radio equipment and licensed operators. The wisdom of this legislation has been so often demonstrated that it requires no discussion today.

We have today exactly the same condition with regard to aerial passenger traffic; and we hope for the passage in the United States (as in other countries) of laws to compel the installation of complete radio sets on every plane which carries passengers. Since we have just witnessed the tragedy of the *City of San Francisco*—which remained a mystery for six days and aroused the entire country because of the mysterious disappearance of the plane and its passengers—it is not necessary to advance much argument to prove the proposition that *radio sending and receiving apparatus must be carried on all existing and future aircraft.*

The recent round-the-world trip of the dirigible *Graf Zeppelin* has shown what tremendous service radio equipment gives during flight, by keeping the aircraft in touch with land at, practically, all times.

In the case of the *City of San Francisco,* the value of carrying radio equipment is likely to be questioned by some. Aviation experts might offer the argument that, even though the T.A.T. airplane had been equipped with radio, no purpose would have been served, because it is doubtful that there was an opportunity to use it. The crash came when the airplane flew against the side of a mountain; and it is most probable that the pilot did not realize how close he was to the mountain until one or two seconds before the crash. What good, then, they might ask, would the best radio set have been, if there was no time to use it? Yet this is no argument at all; for the following reasons:

Every airplane should be equipped with a semi-automatic radio set which requires no operator to use it. There are already in existence and use, radio transmitters which by means of automatic machinery can send out certain signals; or if necessary, the pilot himself can use a short-wave radio telephone set, which need not have a range greater than 25 or 50 miles. This, then, would be the procedure:

On the ground along the airlane, every 25 or 50 miles, there would be located a radio receiving set to pick up the signals as the planes pass overhead; this would be similar to the block signals of the railroad. If there were such ground stations then, if an airplane came to a sudden crash —as did the *City of San Francisco*—the location of the plane could have been easily determined as being between two points; that is, the ground station last spoken to and the one immediately ahead which had not yet been reached. The search therefore would narrow itself down to a comparatively small area.

Not all planes, however, when in trouble will come to such an untimely end as the unlucky T.A.T. plane; but many aircraft in the future will have to make forced landings. Then the radio set will become of even greater importance; because the location can be given immediately and assistance can be quickly brought to the wrecked plane. This will be of great importance in night flying and during the winter, when snow covers the ground and it is necessary to reach a disabled plane speedily in order to rescue passengers and crew.

Most of the arguments against radio on planes heretofore advanced are based on the necessity of having a radio operator, and the additional weight of the radio set. This no longer need worry us; because there are nowadays available very compact and light radio sets which complete, weigh less than 75 pounds. If regulations are made that the pilots of passenger planes must have a training in radio, the argument about the additional radio operator also falls away. It is comparatively simple to understand a radio-telephone set and, if such is not desired, it is possible to use a semi automatic set which is operated by merely pressing a button and which will send out automatic signals as the plane flies over its respective ground-control stations.

Incidentally, if the ground-control stations are also utilized to send out weather reports, warning of storms lying ahead directly in the path of the airplanes, many accidents can thus be prevented. No extra operator is required, because this information can be given by radio telephone; and all the air operator or attendant need do after reporting his progress is to listen to the ground station for a reply.

If this system had been used with the *City of San Francisco,* the plane might have been warned; and thus it might have taken a different course or come down to earth, instead of flying on an unknown course.

Cities in the Air

by Edmond Hamilton

Our gunners, following the orders of the First Air Chief, were concentrating their fire on the European column's head, there in the ocean's green depths.

"CAPTAIN Martin Brant, of American Federation Air-Cruiser 3885!"

As the high clear voice rang through the bridge-room of my racing cruiser, I turned toward the distance-phone from which it issued. Pressing a stud beneath the instrument I answered into it.

"Captain Brant speaking."

"Order of the First Air Chief to Captain Brant: You are informed that the European and Asiatic Federations have combined in alliance to launch a great and unexpected attack upon the American Federation. The European Federation fleet of five thousand air-cruisers is now racing over the Atlantic toward NewYork and other eastern cities, while the Asiatic Federation fleet of the same size is heading over the Pacific toward our western coasts. All American cruisers patrolling east of the Mississippi, including your own, are ordered to head at full speed toward New York, where our eastern squadrons are assembling to meet the European Federation fleet. Upon arriving there yourself and all other squadron commanders will report at once to the First Air Chief."

The clear voice ceased, and I turned from the distance-phone to meet the startled eyes of Macklin, my first officer, who stood at the cruiser's wheel beside me.

"Head eastward—full speed, Macklin!" I cried to him. "It's war at last—war with the European and Asiatic Federations!"

Instantly Macklin swung over the wheel in his hands, and as he did so the whole long bulk of our cruiser swung likewise in mid-air, curving up and backward to race eastward above the green plains, the descending sun at our backs. A moment more and the cruiser's long torpedo shape, gleaming and unbroken metal save for the rows of portholes and the raised, transparent-walled bridge-room in which we stood, was splitting the air eastward at a speed that mounted with each moment. I reached for the order-phone, and as Hilliard, my young second-officer, answered from the motor-rooms beneath, I informed him briefly of what had just been told me. Then there was a muffled cheer from the hundred-odd members of our crew, beneath, and a few minutes later the drone of the great motors had reached to an even higher pitch, and we were racing through the sunlight high above the earth at more than a thousand miles an hour.

Standing there with Macklin in the bridge-room as we shot eastward, though, my thoughts were grave enough despite the exciting quality of the news we had just heard. War!—the war that we of the American

CITIES IN THE AIR

By the Author of "The Hidden World"

Federation had expected, had feared for decades. It had not been more than thirty years since the third Air War of 2039. Three mighty nations alone now shared the world between them; the American Federation, comprising the whole North and South American continents, with New York as its capital; the European Federation, which included all Europe west of Caucasus and all Africa, its center at Berlin; and the Asiatic Federation, which held all Asia and Australasia for the brown and yellow races, with Peking as its capital.

EDMOND HAMILTON

And though for three decades now there had been peace between them, it had been an uneasy peace dictated by the fact that each feared to attack another lest he be attacked by the third. The great navies of air-cruisers of the three mighty Federations had patrolled the air in ceaseless vigilance, their air-forts ever watchful. Lately, however, it had become apparent to all that a rapprochement had taken place between the European and Asiatic Federations, and such an alliance could only mean an attack upon our own, the American. So we had stood even more vigilantly upon the watch, and now that for which we had waited had come at last, and the two great Federations had launched their two mighty fleets upon us.

Gazing ahead, as our cruiser drove onward, I was as silent as Macklin, at the wheel beside me, and as young Hilliard, who had come up into the bridge-room from beneath. Far beneath us the green plains were rolling swiftly backward, as our motors hummed their unceasing song of power. Those great electric motors drew their current in limitless quantities from the electrostatic or atmospheric electricity surrounding the earth, by means of great transformers that changed it from electrostatic to current electricity to give us a power that could hurl us forward with almost unlimited endurance and speed. Connected as they were to our great horizontal tube-propellers, which were set in the cruiser's walls and which moved it forward by drawing immense volumes of air at vast speed through themselves from ahead, those motors could fling us on at more than a thousand miles an hour. This utmost force, as our indicators told us, was shooting us eastward now.

Beneath us the green plains had given way to the great tumbled folds and peaks of the Alleghanies. Somewhere to the south lay Pittsburgh, and to the north Cleveland and Buffalo, but being headed directly to New York, we therefore did not see them. Beneath us we could make out in swift flashes of vision masses of the air-traffic between those cities, great passenger-liners and bulky freight-carriers and slender private craft, but in our own military-craft level there moved only a few cruisers like our own racing eastward toward New York in answer to the alarm. With these, however, there was small danger of collision.

Now the Alleghanies had dropped behind and we were rocketing over the rolling, pleasant countryside that lies between them and the eastern Appalachians. As we shot on I gazed downward, over the green and silent and empty landscape rushing beneath us, and wondered momentarily what a citizen of fifty years ago would have thought to see this once-populous land over which we were speeding lying as lifeless and deserted beneath us as it was now. Then it had given way to the greater folds and ridges of the Appalachians, and then, as we shot on and over their tumbled masses, Macklin lifted his hand from the wheel to point ahead.

"The air-forts!" he said.

HERE is one of the most extraordinary stories that it has been our good fortune to read. For sheer audacity in construction, excellence in science and breath-taking adventure, this story undoubtedly stands in the foreground of science air-fiction stories of the year.

The recent advances in aeronautics where airplanes have been in the air for weeks at a time without coming down to the ground, point the way for tremendous achievements in the generations to come.

City life today is a conglomeration of structures close together. We have buildings now that house as many as 40,000 people at one time and soon we will have single business buildings that will house 100,000 and more individuals at the same time. Furthermore, every doctor will tell you that living at the surface of the earth is usually unhealthy because of the dust and the high density of the air, which gives rise to most pulmonary diseases, particularly consumption, colds and the like. At high altitudes such diseases tend to disappear. Therefore physicians usually send their afflicted patients to the higher altitudes.

You may be sure that conditions such as are described by the author of this marvelous story will come about sooner or later.

We also know that this story will arouse a great storm of discussion among our readers, due particularly to the audacity of the author in picturing his ideas as to future aviation—which by the way will not seem so fantastic two hundred years hence as they might seem now.

On to New York

SWIFTLY they were looming before us as we rushed on toward them, giant domed cubes of dull metal, each five hundred feet in width, that hung in a great, curving line in mid-air before us, five miles above the green land. At intervals of five miles they hung, floating motionless there in a great grim chain or ring, the metal sides and dome of each bristling with great heat-guns like those of our own cruisers, and with narrow openings from which the occupants could gaze forth. Each of these great air-forts, we knew, was suspended thus high above the ground by the gravity repelling effect of the cosmic rays. It had been but fifty years since the machinery had been discovered which directed the great power of the cosmic rays to

overcome the force of gravity. It had been found that the rays could be collected and their power concentrated in the structures that they were to support. Dynamic towers were used for the collection of this great limitless energy.

In a great ring they hung before us, the line of them curving away vastly to right and left, a great ring that encircled and defended New York, as air-forts hang in rings about all air-cities for defence. Then as we drove toward the nearest of these great fortresses of the air, there came from the distance-phone before me its sharp challenge.

Swiftly I replied to that challenge and then we were driving past the air-fort, past the openings in its walls through which we could see those inside standing ready at the great heat-guns. We heard faintly their cheers as we flashed past them toward the east; we cheered ourselves somewhat by the sight of the air-forts. They could maneuver in space in any direction, though at only a fraction of the speed of the air-cruisers. They would form a stubborn defence for New York, we knew, though incapable of meeting alone a swift invading fleet. But now far ahead, as we rushed within the mighty ring of the air-forts, we glimpsed the gray gleam of the Atlantic's vast expanse, stretching away to the east, the green, irregular coastline, the narrow little island, between a larger island and that coast, that had been the site of the New York of fifty years before. Green and deserted as all the countryside behind us it lay now, but I glanced at it only, looking up as there came a low exclamation from Hilliard, beside me.

"New York!"

Full before us lay the mighty city, now, waxing with each moment greater as we raced on toward it. The air about and beneath us was filled with the great swarms of cruisers like our own and of merchant-traffic that was converging from north and west and south upon it. For the moment we three gazed toward it, forgetful of the peril that had brought us to it. We were caught and entranced as always by the splendid and superb beauty of this New York. For it was a New York immeasurably different from that city upon the earth, that decades ago had born its name. It was a city, not of the earth, but of the air.

It was a city whose close-clustered spires and towers and pyramids had been gathered together upon a vast metal disk-like base, and hung suspended five miles above the green earth! It was circular in form and of five miles diameter, the colossal metal base or disk upon which it rested more than a thousand feet in thickness, the metal buildings and towers that rose from that base and were integral with it soaring for five thousand feet farther upward! A colossal city floating there in the air, with its streets and buildings swarming with activity, with thronging hordes, and with great masses of fear-driven craft speeding through the air toward it from all directions.

A city of the air! Suspended by huge batteries of great electrostatic motors in its base, motors that drew the exhaustless energy of earth's atmospheric electricity from countless slender pinnacles that soared from the central plaza; whence the current was conducted along cables within the pinnacles to the giant motors beneath. The cities too were suspended by the gravity-repelling quality of the collected cosmic rays. To this had mankind come, at last. The flimsy airplanes of a good century before, with their little endurance records of weeks and months in the air, had given way to the great electric-driven cruisers which drew their power from the static about them, and which could stay aloft indefinitely. And then had come the great air-forts, held aloft in the same way, and finally, when the great air-wars had made life upon the ground so unsafe as to approach suicide, then had come the construction of giant metal cities, on huge metal bases, that contained enough great motors and tube-propellers to hold themselves in any direction at moderate speed.

The Great Conference

SUCH now were all the cities of earth; Chicago, San Francisco, Buenos Aires, Berlin and Tokio. Great cities that hung always in mid-air, usually near the sites of those vanished cities of earth from which they had gained their names. But the air cities could move from place to place now and then for better climate or defence. These great cities held within them all the world's population; the earth beneath being used only for the mining of metallic ores and the minerals used in the creation of the synthetic foods and fabrics now universal.

The great cities were each protected by a ring of air-forts, and also by great batteries of heat-guns set within their own walls. A hundred of such huge air-cities there were in the American Federation, holding in their colossal masses of clustered sky-flung towers an average of five million inhabitants each. And in the European and Asiatic Federations combined, I knew, there were more than two hundred mighty cities of the air.

Now, though, it was the huge air-city of New York that held all our attention, and as we rushed closer toward it I saw that above it, above the panic-driven masses of aircraft that were swirling down to take refuge within it, there hung squadron upon squadron of cruisers like our own, over two thousand in number, hanging there in grim, motionless ranks, as though unconscious of the swarming, fear-driven activity in the huge city beneath them. From every quarter other cruisers were arriving to join those squadrons, cruisers that came like our own from patrols over the green inland plains, from above the icy Labrador wastes, from over the jungle-bordered Caribbean coasts, all rushing to answer the call to arms. As our own ship neared the city, we headed down toward the central plaza.

"Straight down to the central plaza, Macklin," I said. "The First Air Chief will be there and orders are to report to him first."

Macklin had already slowed our ship's speed, and now as we drove to a position beside the aspiring central pinnacle, with its clustered points, the city's static-tower, he turned the power of our motors completely from our horizontal tube-propellers, into our vertical ones, which held us motionless in mid-air. Then, as he slowly decreased that power, we sank smoothly down until in a moment more we had come to rest upon the smooth central plaza among a score or more of other cruisers. These rested in a great ring about the plaza's edge, their crews waiting within them, but at the center of that ring, beside the mighty static-tower's base, stood a little group of men, the First Air Chief, Yarnall, and his squadron-commanders.

As our cruiser came to rest I opened the door beneath the bridge-room, and stepped onto the metal plaza and across it toward that group. Around the great plaza, I noted, were vast, seething crowds, thousands upon thousands of the mighty air-city's inhabi-

tanta. Other thousands were gazing down toward us from the towers that soared around us into the golden afternoon sunlight. These people, watching us and the mighty fleet hanging grimly far above, were silent, but from beyond them there came to my ears from far across the air-city's mighty mass, the dull roar of millions of blended voices, in unceasing, excited shouts. Then I reached the First Air Chief and the group before him, my hand snapped to a salute, which Yarnall silently returned. And then, gazing for a moment in silence from one to another of us, his strong face and gray eyes grave, he began to speak to us.

"You, the squadron-commanders of our eastern forces," he said, "know why you have been summoned here, why I, under the orders of the Federation's Central Council, have summoned here you and all the cruisers that wait above us. The great European Federation fleet, twice as large as our forces, is rushing westward over the Atlantic toward us, and within the hour we must meet that fleet in battle."

He paused, and in the silence that ensued the dull, dim roar of the great city about us seemed suddenly infinitely remote from our ears. Then the First Air Chief went on.

"Within the hour we must meet that fleet in battle and as we go out to meet it our western forces will be going out from San Francisco, under the command of the Second Air Chief, to meet the Asiatic Federation fleet racing eastward toward it. And upon those two battles rests now the fate of our nation. If they are lost, if either of them is lost, within days our nation will be but a memory, our cities annihilated. If the two approaching fleets are defeated and beaten back, then we shall have won for ourselves a respite in which we can prepare to meet the great enemies that crowd now upon us. So I say to you, the Central Council says to you, that this battle must not be lost!

"The fleet that we must meet has twice the number of cruisers of our own, and there have been rumors of some new method being prepared by them with which to attack us, now or later. We have to aid us only the air-forts about this city, which have been equipped with a new device. I have ordered them to move east of the city to lie between it and the enemy. This great air-city itself, when we go out from it, will move inland at its highest speed away from the battle, just as Boston and Charleston and Miami and San Francisco and Los Angeles and all our great air-cities, north and south. There will be, therefore, none but our cruisers gathered above and our air-forts massing eastward to fight this battle upon which the Central Council has staked our fate.

"But great as these odds are against us, this battle must not be lost! We are the sons of the Americans who fought through the First and Second and Third Air Wars, who reared this nation out of the blood of a thousand air battles until now its hundred air-cities hold in their power a third of all the world. And now that the rest of that world comes against us, the Last Air War begins. My word to you is this: Fight only as those men before you fought, and before tomorrow the European Federation fleet shall have been beaten back—or the last of our cruisers and our air-forts and ourselves will have perished!"

There was silence as the First Air Chief ceased, and then from us assembled commanders there broke a great cheer, a cheer that was taken up by the massed thousands around the plaza and that spread like fire over all the great air-city about us. Then we all returned toward our waiting cruisers, the First Air Chief toward his own, and a moment later his cruiser, with its three parallel stripes of silver running from stem to stern distinguishing it from all others, was rising smoothly upward, followed by our own. Upward we shot, a vast roar coming up to us from the mighty floating city beneath us. Then our score or more of ships were taking their places each at the head of its squadron of a hundred ships, while the First Air Chief in his silver-striped flagship rushed to a position at the head of all. There we hung, the dull, great roar coming unceasingly up to us from the city below, and then as an order sounded from the distance-phones of all the fleet we were moving forward, eastward, out from over the great air-city, from over the green coastline, out over the gray expanse of the Atlantic.

With Macklin and Hilliard again beside me as our own cruiser moved forward at its squadron's head, we three turned to glance back. We saw New York, its mighty towers splendid against the descending sun, moving also, but slowly westward and away from us, away from the coming battle, dwindling to a dark spot and vanishing as we raced on outward over the gray Atlantic. Now we were racing above the great air-forts that had massed in a great double line a score of miles out from the coast, high above the waters. Over these too we sped, at steadily mounting speed, until with great motors droning, crews shouting as they ran our heat-guns out from tops and sides and keels, winds whining shrill about us, our great fleet reached its maximum speed toward that great oncoming battle by which our Federation was to stand or fall.

CHAPTER II

The Battle Over the Atlantic

GAZING ahead, Macklin and Hilliard and I stood together in the bridge-room of our cruiser. The squadron which we headed was at the lead of one of our fleet's great columns. Far behind us stretched its ships, flashing forward at uniform speed. Then from the distance-phone before us came the First Air Chief's voice.

"Squadrons 1 to 6 take up scouting positions!" he ordered.

Instantly the first six squadrons of the two columns, our own one of the first, leapt forward and out from the two great lines of the main fleet. Our own and another squadron moved straight ahead, past the silver-striped flagship of the First Air Chief, until our two hundred ships had spread out into a great, thin fringe that was flying forward miles before the main body of our fleet. Two of the other four squadrons drove to right and left of the fleet, spreading their in the same way, the remaining two taking up positions high above and far beneath our two great columns. Thus, with its great lines of scouts fringing it and protecting it from surprise on all sides, our great fleet drove on toward the east over the gray and endless plain of the Atlantic, holding at Yarnall's orders a speed of eight hundred miles an hour.

The crimson descending sun flaming in the heavens behind us, the great gray ocean stretching endlessly beneath us, we rushed on through empty sea and sky. By then Hilliard had gone down to take up his position with the crew beneath, but Macklin and I still stared into the great empty vista before us. With the drone of our great motors and those of the scouts

flying beside us, we seemed like a great flight of bees. Beneath there was no sound now from the crew, a silence that told of the tenseless, of expectancy. But still before us was no sign of the great fleet that we had come out to meet, and almost it seemed that in spite of our certain information as to its course we had missed it, since already we were some hundreds of miles out to sea. Then suddenly, as I gazed ahead, I caught my breath, and the next moment had turned swiftly to the distance-phone.

"Squadron 1 reporting," I said rapidly. "The scouts of the European Federation fleet are in sight and are heading toward us!"

For there ahead a great line of dark dots had appeared suddenly in the empty sky, a great fringe of dark dots that were rushing toward us and that were becoming quickly larger! With each moment that they raced toward us they became larger, until they had come plain to our eyes as long torpedo-shaped cruisers like our own. They differed from our own only in that their bridge-rooms, instead of being raised like our own, were sunk flush with their upper-surfaces, only their transparent forward-windows showing. They were the scouts of the European fleet, and at the same time I saw them they must have seen us, for they changed their course slightly. So racing straight toward us were five hundred cruisers opposing the two hundred of our far-flung line. On and on they came, and I saw momentarily far behind them a great cloud of other cruisers, the mighty main body of the European fleet. I shouted the information into the distance-phone. Then the next moment the speeding line of cruisers before us had rushed straight into our own onrushing line!

The next moment all the air about us seemed filled with whirling, striking cruisers, as the two scouting lines met and crashed. In that first moment a score of our cruisers crumpled and collapsed in headlong collisions with European cruisers. And then as Macklin threw the wheel up at my hoarse cry, our own ship heeled over with sickening speed to avoid two European cruisers hurtling straight toward us. Then as we rushed by them there came the swift sharp detonations of their great heat-guns and a storm of shining cylindrical heat-shells rushed from them toward us. At that moment Macklin swung our cruiser back upward and over the two rushing European ships, and as there came a word from Hilliard to the crew, our own keel heat-guns rained down a score of heat-shells upon the two ships. One of those ships the heat-shells missed, but the other was struck squarely by three of them.

Instantly there was a blinding flare of white light as the striking heat-shells burst, releasing upon the luckless European ship all the terrific heat contained within them, the vast vibrations of radiant heat. For this was the most deadly weapon of modern air-warfare, these shining shells in which, by special processes, the vibrations of intense radiant heat could be concentrated. And as those shells struck and burst upon the luckless ship below we saw the ship hang motionless for a moment in the midst of that blinding flare, its metal sides glowing and fusing. Then we saw it plunge downward like a great meteor toward the gray Atlantic!

But now our own cruisers were whirling up and backward, back toward the struggling ships that hung now in a mighty, struggling line. Like swooping hawks our own craft flashed, diving down upon that battling line with bow and keel guns raining heat-shells upon the European ships below, racing down at a giddy angle into that wild melee of struggling ships and heat-shells that the combat there had become. So wild and fierce had been the combat in the few moments since we had met the European scouts that already scores of ships had plunged down in white-hot destruction toward the ocean. But we had, I saw, well accounted for ourselves in those moments, since almost twice as many of the European cruisers had fallen as our own, and they seemed staggered. Then as our ships leapt like angry birds of prey after them, there came a quick order from the distance-phone that abruptly halted us.

"Main body of European forces approaching! All front and side scout-squadrons rejoin our fleet!"

Trapped!

INSTANTLY Macklin whirled our cruiser again up and back, and as the rest of our scout squadrons turned and leaped back through the air after us, we saw that the battered European scout-lines were receding also, racing back toward their own main fleet. That mighty fleet was in full sight to the eastward now, its five thousand great cruisers advancing majestically toward us in the familiar battle-formation of the European Federation—a great ring or hollow circle of ships. On they came, the scouts taking their place within that circle with the rest. Then we, too, had fallen back into place at the head of our own two great columns, the silver-striped flagship of the First Air Chief before us, and slowly now, with ten miles more of clear air between them, the two giant armadas were advancing toward each other.

Standing there with Macklin, heart pounding, I gazed watchfully ahead as our fleet and the European one swept nearer toward each other. We came each withholding our fire for the moment, since the heat-guns have but a short effective range. Although outnumbered two to one, we were moving steadily toward the oncoming giant circle of the enemy. Then suddenly the ships of the great European fleet, still holding its circular formation, had leapt steeply upward with sudden tremendous speed, to slant above us!

As they did so, a quick order rang from the distance-phone and the two great columns of our fleet had leapt upward also, up to the level of the other until a split-second more would have seen us crashing headlong into that oncoming circular fleet. I saw the air before me filled with gleaming ships rushing lightning-like towards us, heard another order ring out, and then Macklin had swung our cruiser to the right and our whole great fleet had divided, one column flashing like light to the right of the oncoming European fleet and the other column to the left of it. Before they could change formation or slant down to escape that swift maneuver of ours, we were flashing past them on both sides, and then to right and left of them our heat-guns were thundering and loosing a storm of swift heat-shells.

As those shells struck, as our passing column loosed a hail of them upon the European cruisers, the air about us seemed filled completely with blinding bursts of light and heat. Scores, hundreds, of the enemy ships were withered by that deadly fire from right and left, glowing and melting and plunging downward like chariots of white fire.

Surprised as they were by our swift maneuver comparatively few fired upon us as we raced past them,

but even those few shells found their marks among the cruisers of our rushing column. Cruisers of my own squadron were struck and hanging there glowing and fusing from the terrific heat released upon them, unable to avoid the fast-speeding ships behind them which raced headlong into the white-hot wrecks. Then our columns were past them and as behind us their ships fell thick in white-hot melting ruin, I turned toward Macklin, exultant.

"We're beating them!" I cried. "Another blow like that one and——"

A cry from the second officer cut me abruptly short, and quickly I gazed back to where he was pointing, toward the mighty ring of the European fleet. Our two columns had converged inward toward each other after that deadly blow, when the great ring-shaped formation of cruisers behind us had halted abruptly its own forward flight, and had shot back a great double file of its cruisers between our own two racing columns! And then, before we could see and forestall its menace, before we had time to obey the swift command that the First Air Chief shouted from the distance-phone, that double tongue of ships had split, each line moving sidewise with terrific force and speed toward our own two lines, pressing them outward from each other, separating them, rolling them sidewise and backward in two great enveloping motions.

In that moment I felt our cruiser reel madly as a European cruiser shot against it, saw Macklin clinging madly to the wheel as I was thrown down and backward, while about us in that mad moment the heat-shells were speeding forth from ship to ship to burst in flaring destruction about us. Then as Macklin swung our cruiser up to a level keel, our heat-guns beneath detonating now as our gunners worked them like mad beings, we were fighting the remorseless lines of the enemy that swept us back and I was aware that our fleet's two columns had been swept hopelessly apart, that our forces had been fatally divided and that each division of them was now completely encircled by the outnumbering masses of cruisers of the European fleet!

Cruisers on all sides of us now seemed to fill the air, enemy cruisers that tossed about us in a great sea of ships and that made our own ships the target now of their unceasing volleys. Our column, rolled together by that irresistible maneuver, had massed into a solid group, the silver-striped flagship of the First Air Chief just beside our own. The air around us was livid with flares of blinding light as the heat-shells broke and burst in unceasing destruction, as the thunder of our detonating guns seemed to drown all other sounds in the universe.

Not for long could we thus remain the target of these masses of cruisers that swarmed about and above and beneath us. Our other column had been swept back and that was surrounded by enemy cruisers and fighting desperately even as we were. Unless we could join them, and reunite our shattered fleet, we must inevitably be destroyed. At that moment the voice of the First Air Chief rang from the distance-phone before me in a high command.

"Triangle formation!" he shouted. "North at full speed!"

Instantly the ships behind and about us, reforming swiftly and smoothly even under the rain of shells shifted into a great wedge-shaped formation, a great triangle of solid ships whose apex was the First Air Chief's cruiser, and which pointed north, toward the other isolated and struggling half of our fleet. Then the next moment our great triangle had leaped forward straight toward the north at full speed, into the swarming masses of European ships that surrounded us. Our own cruiser hung just behind the First Air Chief's, just behind the triangle's apex. Then with a terrific crash we had smashed into the solid wall of ships before us.

Our cruiser rocked and reeled beneath me as its sharp stem rammed at full speed into a European cruiser that had swung broadside in an attempt to escape us. Its side crumpled beneath that awful blow and I saw it reel back and downward, I felt other rending crashes that shook our ship wildly as our triangle crashed through the European fleet. Then suddenly we were through it, had smashed our way by sheer force through its sea of ships and had reached the second half of our fleet, joining with it once more. Scores, hundreds even, of our own cruisers and of the enemy's were tumbling and twisting downward toward the sea, battered wrecks of metal that had been all but annihilated in our mad crash through the enemy armada!

Now swiftly our re-united fleet, still almost two thousand strong, were massing together in a single long rectangle, our flagship speeding to its head, and as we moved toward the scattered swarms of European ships about us, that numbered almost four thousand still, they had formed into a similar formation. Then as our own long rectangle or column rushed toward them they were racing sidewise at the same speed as ourselves, so that side by side now our two great fleets sped through the air, our heat-guns detonating again as we held still to the awful struggle. Our cruiser seemed to bear a charmed life, since as we drove headlong through that hail of shining death, behind the First Air Chief's cruiser, we were sometimes missed by inches only. And now as Macklin, his eyes steady but burning, held our ship onward with those about us in this mad running fight of the two great fleets, I was aware that in that fight they were both slanting steadily *downward*, down toward the gray Atlantic far beneath!

Fleet hanging to fleet, the air between them thick with shining heat-shells, down we rushed until we were within yards and then feet of the ocean's tossing surface! But, still firing at each other steadily, they were swooping downward still until we were plunging straight down into the ocean's depths. For these great air-cruisers could move beneath water as well as through the air. Each opening in them sealed tight during flight, their air-supplies always automatically furnished by great tanks of liquid-air, their great tube-propellers sucking water through them at immense speed even as they did air, and hurling the cruiser on at a speed which while far less than that in the air was still great—with these features our cruisers were now down into the great waters of the Atlantic.

"Hold steady!" I cried to Macklin as we swooped downward, and the waters rushed up toward us. "Keep in line with the First Air Chief's ship!"

I saw his hands clench upon the wheel, and then the waters were just beneath us, were rushing nearer and nearer, while even then our ships and those about us were loosing their heat-shells upon the European fleet whose great column was plunging downward like our own. Down—down—and then with a shock our cruiser had plunged into the great waters, had rushed beneath the waves, and instantly the light of sun-

set all about us had vanished, had given way to the green translucence of the waters. Through that green obscurity there shot yellow shafts of revealing light, the under-water searchlights in the walls of our cruiser which I had snapped on. From all the ships before and behind us came other brilliant shafts. Our great fleet still grappled with the European fleet rushing down to our right, our heat-guns loosing their deadly shells still through the green waters toward each other's fleet! The great battle over the Atlantic was to be carried on in the great ocean's very depths!

CHAPTER III

Under the Sea

GREEN depths that swirled about us, shafts of yellow light that swung and stabbed through them, rushing cruisers and detonating guns and drone of motors and wild shouts—all these merged and mingled in one great phantasmagoria of strange impressions in those first moments. I had shot under the ocean's surface in my cruiser many a time before, but never in battle. And now, with our two great fleets plunging down into those peaceful depths, all about me seemed for a moment a strange dream. Then I saw before us, the cruisers of the First Air Chief and those about him, dark long bulks that gleamed there in the depths beneath us as the yellow shafts of light struck and crossed them.

Peering downward, figure tensed over the wheel, Macklin was holding the cruiser behind those rushing ones ahead, and now, looking away to the right, I could make out the dark, long bulks of the European cruisers also. And across the gap from fleet to fleet were hurtling storms of the heat-shells still, shot forth by our great heat-guns whose valve-breeches made them capable of underwater operation. And as they burst there broke from them the same great flare of light and heat as in the air above, little affected for the moment by the waters about them, destroying in that moment the ships they struck and making the waters about those fusing ships boil terribly with their terrific released heat.

But straight downward through those boiling waters swirled and swept the following cruisers of the two great fleets. As our guns thundered there in the great deep, as heat-shells raced and broke and flared about us, I saw schools of fish and strange sea-creatures and denizens, for a moment in the glow of the yellow searchlights or the flares of bursting heat-shells. The fish were all striving desperately to escape from this hell of battle and death that we men had carried down with us. And still downward—our two great columns were racing, hanging to each other with fierce, resistless tenacity, raking each other still with the great heat-guns as we shot lower into the mighty depths!

Finally Hilliard dashed up into the bridge-room from below.

"This can't keep on much longer!" he cried. "The cruiser's walls can't stand this heat and speed!"

"It'll have to keep on as long as the First Air Chief keeps on!" I shouted to him, over the drone of motors and thunder of guns. "If the battle is to end for both fleets here—let it!"

But I saw even in that moment that Hilliard was right, and that the walls about us, the transparent metal of the windows, had become searing to the touch. Not only had we raced through areas of water boiling at terrific temperatures from heat-shells that had burst in ships there, but our own immense speed was producing by its friction with the waters a heat that was almost softening the cruiser's walls. Yet I saw that still the First Air Chief's cruiser was rushing deeper and deeper before us, and that still the great column of our own fleet and that of the European fleet were following locked in that colossal death-grip, their heat-guns thundering still toward each other.

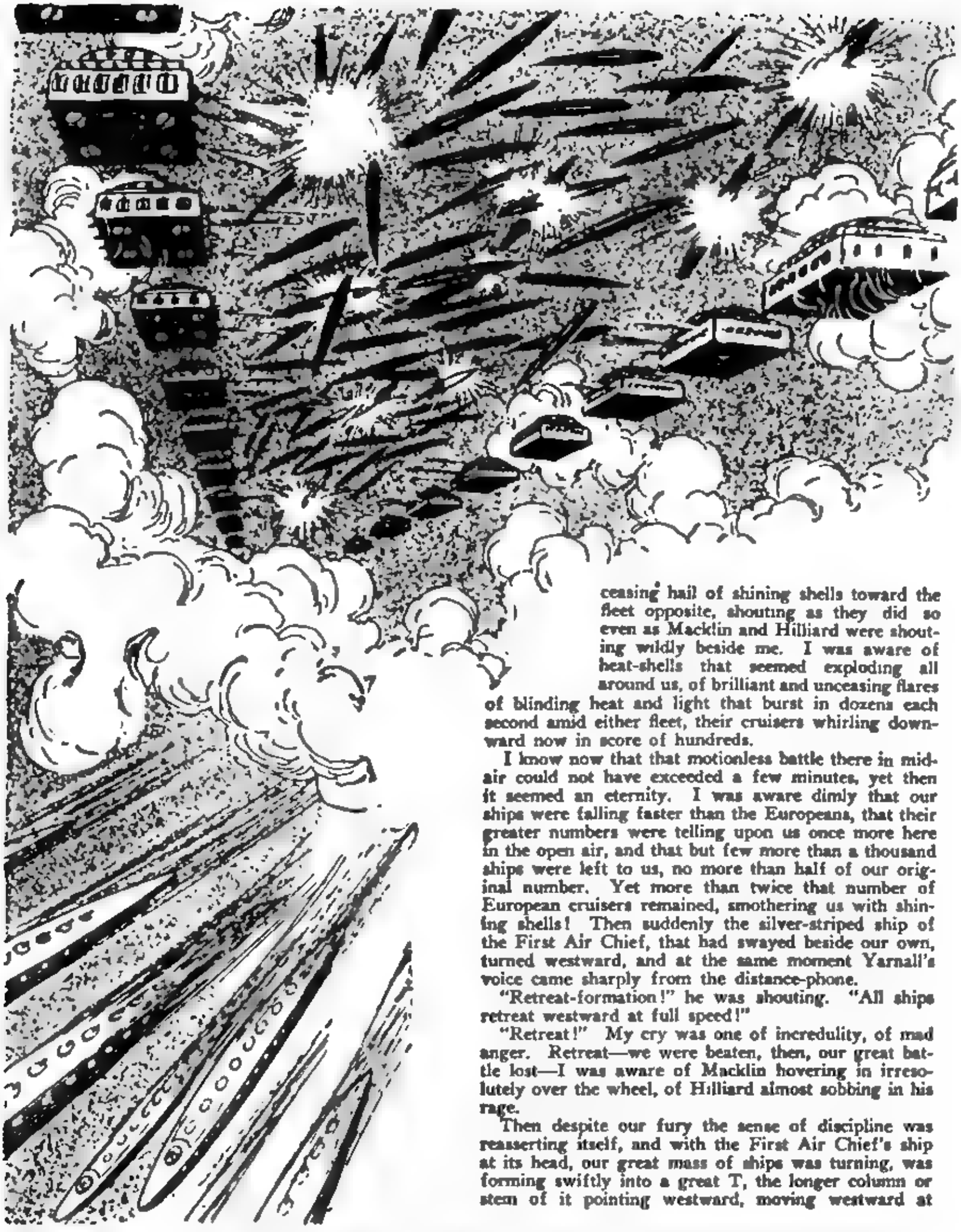
I could see too that the cruisers of the European fleet were suffering far more than our own in this awful undersea battle, since there in the green depths, only able to half see each other and to aim their heat-guns by the uncertain light of their searchlights, their greater numbers were of but small advantage to them. And our gunners, following the former orders of the First Air Chief, were concentrating their fire upon the European column's head, so that when ships were struck there by heat-shells, changed to motionless white-hot wrecks in the waters, those behind were unable in the green depths to see them in time to swerve aside, and so crashed into the fusing wrecks and were themselves destroyed. It was a maneuver that the First Air Chief had long before explained to us for use in undersea warfare, and now it was proving of the highest effectiveness and score after score of the European ships were flaring and crashing in their opposing column.

For only a moment more, though, did the two great columns continue thus, for then the European fleet, feeling the great losses which it was experiencing in this terrific underwater combat, responded suddenly to some order, curving sharply upward again. Instantly the First Air Chief snapped an order from the distance-phone, and instantly our own great column of ships had turned upward too, had curved upward through the waters after the racing European fleet like wheeling sharks after prey, their guns and ours still beating a tattoo of thundering death there in the great depths. Now as we rushed upward again at undiminished speed the waters were becoming green and translucent once more. Then as we flashed up through those green depths, heat-guns sounding still from fleet to fleet, the cruisers ahead and above us, and then our own, burst suddenly up from the waters into the sunlit air once more!

Into the Clouds

SURELY some battle out of a nightmare was this, in which our two great masses of cruisers hung still with deadly purpose upon each other. Macklin and Hilliard and I aware of ourselves now only as infinitesimal and unreasoning parts of this mighty fleet about us, moved upward, miles again above the waves. The two rushing fleets slowed, halted, as though by mutual purposes. Slowed and halted there in two great masses of cruisers in mid-air, our own to the west and the European one to the east, and then, with every heat-gun detonating and with the air between them seemingly filled with shining, hurtling shells, they were hanging motionless in a mighty death-grip!

The great struggle for its sheer intensity was appalling, as the two giant fleets hung there unmoving, high in the air, each unheeding its own danger, intent only upon annihilating the other. I was aware, as though I were a spectator, that I was shouting hoarse commands into the order-phone, that in obedience to those commands our gun-crews beneath were working the great heat-guns like madmen, loosing an un-



ceasing hail of shining shells toward the fleet opposite, shouting as they did so even as Macklin and Hilliard were shouting wildly beside me. I was aware of heat-shells that seemed exploding all around us, of brilliant and unceasing flares of blinding heat and light that burst in dozens each second amid either fleet, their cruisers whirling downward now in score of hundreds.

I know now that that motionless battle there in mid-air could not have exceeded a few minutes, yet then it seemed an eternity. I was aware dimly that our ships were falling faster than the Europeans, that their greater numbers were telling upon us once more here in the open air, and that but few more than a thousand ships were left to us, no more than half of our original number. Yet more than twice that number of European cruisers remained, smothering us with shining shells! Then suddenly the silver-striped ship of the First Air Chief, that had swayed beside our own, turned westward, and at the same moment Yarnall's voice came sharply from the distance-phone.

"Retreat-formation!" he was shouting. "All ships retreat westward at full speed!"

"Retreat!" My cry was one of incredulity, of mad anger. Retreat—we were beaten, then, our great battle lost—I was aware of Macklin hovering in irresolutely over the wheel, of Hilliard almost sobbing in his rage.

Then despite our fury the sense of discipline was reasserting itself, and with the First Air Chief's ship at its head, our great mass of ships was turning, was forming swiftly into a great T, the longer column or stem of it pointing westward, moving westward at

And now above us the European ships, whirling about aimlessly in the terrific fire that raked them from either side, were falling faster still. And even as they massed together to escape that great death trap, we were rising up after them.

swiftly mounting speed with the flagship at its head, while the shorter column or head of the T lay across its rear at right-angles. This protected us somewhat from the European fleet that now was leaping swiftly after us, triumphant, exultant at our flight. Our stern guns still firing toward them as they leapt upon our track, we raced westward, on until at full speed. And now, even as the thunder of guns still came to our ears from behind, a dull, dead silence reigned over our own ship, and those about us, Macklin and Hilliard as silent beside me as myself, a silence of the apathy of utter dismay and despair. For never, surely, had any American fleet ever thus fled homeward, before, pursued by a conquering enemy.

On to the westward though we raced still, our rear-guard line of cruisers now the targets of numberless heat-guns. Still cruisers among them were being destroyed by the heat-shells, and still, too, they were striking savagely back to find their marks here and there among the mass of our pursuers. On and on we rushed, the European fleet closing gradually toward us, and now we were but a score or so of miles from the coast, I knew, and should be sighting the great double-line of our air-forts that were hanging far out to sea. It was the one chance of escape for our outnumbered fleet, I knew, to gain the shelter of those great forts. And now it was clear that it was with this object that the First Air Chief was leading our fleet in full retreat westward. But as we gazed ahead, we saw that though we should have been within sight of them the great air-forts were nowhere to be seen! Save for a great, long bank of floating white clouds ahead the sky was completely empty, and of the air-forts there was no trace!

"The air-forts gone!" I cried. "Our last chance gone!"

"But our fleet's going on!" exclaimed Macklin. "The First Air Chief's leading us into those clouds!"

The Ambush

GAZING ahead, incredulous, I saw in a moment that it was so, that the First Air Chief's cruiser was flying straight on toward the great long bank of clouds ahead, leading our whole fleet into their fleecy white masses. Even as I stared unbelievingly, I saw his silver-striped ship rush into those clouds and vanish from view, and after it were rushing our own ship and all those about us, all the long mass of our fleet! Unable to credit my eyes, almost, I stared, for it was a suicidal maneuver, to attempt to elude our pursuers in those fleecy masses. They needed only to surround the cloud-bank and then wait and destroy us one by one as we emerged again. Yet even as I gazed forward our ships were speeding into the white masses of vapor, after our flagship, our rear cruisers still returning the fire of our pursuers. Then as our own cruiser flashed into them, all things vanished from about us save the thick masses of cloud-vapor that hemmed us in, that seemed to press against our windows, curtaining all things else from sight!

I stared forth tensely with Macklin and Hilliard in a vain attempt to see through those masses, heard the thunder of guns still going off blindly somewhere in the great cloud-mass behind us, knew that in the wild heat of pursuit the European fleet had rushed after us into that great cloud-bank. Then came a swift order of "All ships halt!" from the distance-phone, and as we came swiftly to a halt there in the blinding, fleecy masses, motors droning still, we heard the crash of ship on ship behind us in the cloud-bank as the foremost cruisers of the European fleet drove blindly into our own, then halted fearfully themselves, milling confusedly about in fear of farther collisions and with neither fleet firing now in the absolute blindness that held each ship. Thus the two mighty fleets hung there for the moment blind and helpless in the huge cloud-bank, and in that moment there came again the First Air Chief's voice from before us in a swift, shouted command.

"All American Federation ships—*drop!*"

Before the order had ceased to echo Macklin's hand had flashed to the power-stud, and as the great drone of our motors suddenly lessened our cruiser dropped downward like a falling stone, plunged downward until in a moment more it had ripped through the great fleecy mass of the cloud-bank and into the open clear air beneath it, leaving the great European fleet for the moment still in it. And in that moment, even as our cruisers halted their plunging downward fall, there came a great hissing sound from above as of the hissing of terrific jets of air, and at the same instant we saw the mighty cloud-bank above breaking up, disintegrating, its great fleecy masses whirling suddenly away in all directions, driven away in a moment as though by mighty winds, breaking away in formless flying vapors! Breaking away to leave clear air where they had been, to leave the European fleet hanging there, appearing to our sight suddenly as a confusedly milling mass of numberless ships above us! And coming to ——? on either side of that confused mass of ships was *the great double line of our giant air-forts!*

"The air-forts!" My cry was echoed in that moment by Macklin and Hilliard beside me, by all in our cruiser, in our fleet.

The air-forts! On either side of the disorganized European fleet they hung, in their mighty double line, and as that fleet saw them now for the first time with the sudden disappearance of the cloud-bank that had hidden them, it seemed to h a n g motionless still as though stunned with astonishment. Then the great heat-guns of the air-forts had swung toward them, were thundering in swift chorus, were loosing storm upon storm of heat-shells upon the confused, astounded ships that swung between them! Were pouring forth in that awful moment all the concentrated fire of their mighty batteries upon the European ships caught between them.

The air-forts! And it was between them, between their two mighty lines, that the First Air Chief had purposely led the European fleet, I saw now. For *this*, then, was the new device of the air-forts of which he had spoken to us before our start, this device which enabled them to surround themselves with a great cloud-bank that kept them hidden from all and unsuspected by any enemy. Some device for projecting forth great masses of water-vapor it must be, that had enabled them to form that great artificial cloud-bank about themselves. And when the First A i r Chief, staking all upon the device, had led the pursuing European fleet into that great cloud-bank, into that giant ambush of the air-forts, then with our own fleet dropping down out of it they had needed only to disperse the artificial cloud-mass about them by means of great air-jets of terrific power, to disperse the cloud-mass and to turn all the fury of their great guns upon the European fleet that hung still dazed there in the withering fire of those suddenly-unmasked batteries!

For now above us the European ships, whirling aimlessly about in that terrific fire that raked them from either side, were falling faster still! Their own shells burst and flared along the sides of the great air-forts, but were too few in number to cripple or destroy any of those gigantic, heavily-armored edifices. And at that moment, even as the European ships strove to mass together to escape from that great death-trap of the air, the First Air Chief's ship was slanting up toward them, and now we needed no orders to follow as we raced up after him. Up until our great fleet rushing upward in a single mass was pouring up before us a third terrific fire of heat-shells which, added to that of the air-forts on either side, sent blinding death-flares dancing and leaping over all the mass of ships above us.

"They're turning!" cried Hilliard. "They're fleeing!"

Homeward

FLEEING! Even as our fleet shot up toward them the European ships, reduced now to hardly more than two thousand in number, and unable to bear the terrific fire concentrated upon them from three directions, were soaring frantically upward above the air-forts, up and away to the eastward, massing together in a close-bunched, irregular formation. And our fleet had shot up after them, sending a rain of shining messengers of death among them as we shot after them, pursuing them with bow-guns firing just as minutes before they had pursued us. Then, broken and disorganized and incapable of further resistance for the time being, the great European fleet was drawing away from us as an order from the First Air Chief halted our wild pursuit. Outnumbered still as we were by two to one we could not carry the pursuit too far from our supporting air-forts.

As we halted, we saw the European ships racing on in a struggling mass, dwindling and vanishing from us quickly against the gathering dusk eastward. Then our own battered cruisers were turning, heading back westward, back toward the brilliant, waning sunset, and with our flagship at our head until we paused above the air-forts. There, with the wild exultation of victory we three in the bridge-room, Macklin, Hilliard and myself, and our crew and all the cruiser crews about us, expressed ourselves in great roaring shouts. And then, once more, there came from the distance-phone before us the voice of the First Air Chief.

"Cruiser-captains and men of this fleet," he said, "we have beaten back the first attack of the European Federation fleet. And I have received but now a distance-phone message from the Second Air Chief, commanding the western fleet out of San Francisco. He reports that his own fleet, meeting the oncoming Asiatic Federation fleet, was able after a battle as terrific as our own to drive it back also, by using the same cloud-ambush device in the air-forts as we used here. Thus on this day to west and east we have accomplished the impossible."

He paused, and at his words, his news, a wilder cheer went up from all our ships and air-forts, hanging motionless there against the crimson of the dying sunset. But now, his voice solemn, the First Air Chief went on.

"We have won today, in east and west, but what we have won is but a respite. The mighty European and Asiatic Federations have gathered all their forces to annihilate our American Federation. Their great fleets have been cut in half by these two battles, but so have ours. And they not only outnumber us still by far, but they can build new cruisers faster than we. Undoubtedly within weeks, days perhaps, there will come another mighty onslaught from them, from west and east, an onslaught for which they have been preparing and are preparing some colossal and terrible plan or weapon of which we know nothing. It is some unknown device that it is rumored will enable them to move gigantic forces upon us. We must stand against them, nor can we hope to surprise them with the cloud-ambushes used by us today. Yet whatever forces they bring against us, whatever giant new weapons or terrific attacks they loose upon us, whatever is the great end of this Last Air War that today has started, you of the American Federation fleet can be proud always of the way this first battle was fought and won!"

There was silence a moment and then another shattering cheer. And then, the First Air Chief's cruiser leading, our fleet was moving smoothly westward toward the sunset, and toward New York. As we moved on our watchful patrols were already out from the fleet's main body to north and south, while behind us the great air-forts, slowly and ponderously, were following us, spreading into a long single line which with the ceaseless patrols was to guard us from any surprise attacks or raids. Already, by now, the dusk was gathering behind and about us, the sunset's light waning in the west. And by the time that our fleet came again in sight of New York the great air-city's outline was visible only as a mass of brilliant lights floating high in the gathering darkness. The mighty city, as we learned, had begun to move eastward to meet us upon hearing of the results of the day's battles, and now glimmered before us like a great mass of brilliant gathered stars, the giant beams of its searchlights sweeping the night.

Onward and down toward the mighty city shot our fleet, and as Macklin and Hilliard gazed down with me we saw the cruisers that landed upon the white-lit plazas across the immense floating city surrounded at once by joyful crowds, their weary crews carried high on shoulders. The whole great city, indeed, was rejoicing, though that rejoicing was not extravagant, being tempered by the knowledge that it was but the first attacks of the European and Asiatic Federations and that other and greater attacks might be expected to follow soon. So although the great city blazed with lights as our fleet slanted down toward it, its great towers and pinnacles and pyramids seeming like magic palaces of radiance floating there in the night of the upper air, yet its great watchful searchlights stabbed and circled still, and there came and went still high above it and to north and east and south the humming patrols, on guard now and challenging every craft that approached the city

Then our cruiser was landing, and Macklin and Hilliard and I were emerging from it with our crew, mindless of the shouting crowds that surrounded every landing plaza, stumbling in our utter weariness through those crowds to our barracks, to fall into a stupor-like sleep of utter exhaustion . . .

The Respite Ended

IT WAS the middle of the afternoon when we awoke, more than a score of hours later. Our quarters lay in one of the uppermost levels of the great barracks-tower, and as I rose and after dressing joined Macklin

and Hilliard at the window, we could see far out over the air-city's great expanse. Above us blazed the afternoon sun shining on numberless patterned windows of all the gigantic metal towers about us. Far overhead there still hummed and flashed the ceaseless patrols, still watchfully hovering above and around New York. Beneath, on the city's landing plazas, there rested still the hundreds of cruisers of our returned fleet, and now we saw that upon the great central plaza where our own ship lay there were gathered now some two hundred and fifty of our twelve hundred and fifty ships, and that about these central ships were swarming a great horde of mechanics and attendants; caring for and inspecting their great motors, filling the liquid-air tanks that supplied constant breathable air, refilling their magazines with shining masses of heat-shells.

I turned puzzled toward the other two. "Strange that they should be giving such swift attention to those two hundred and fifty cruisers," I said.

Macklin nodded, frowning. "And our cruiser among them," he commented. "One would almost think that—" He stopped short as our door snapped open and an attendant stepped inside, saluting.

"Captain Martin Brant to report at once to the First Air Chief's headquarters in the tower," he said, "and all cruiser officers and crews of Squadrons 1 to 4 to rejoin their ships at once!"

Again he saluted and disappeared, leaving us staring blankly at each other. Then we were struggling into the tight black jackets of our uniforms, were striding out in a moment and down to the great air-city's "ground" level in one of the building's electrostatic-motored cagelifts. Through the crowded streets we strode, seeing now that in all those streets other black-uniformed men of the squadrons named were pressing toward their cruisers in the central plaza. Then we three had reached that central plaza, from whose center rose the mighty electric power-tower, and around which the two hundred and fifty cruisers rested, all of our first four squadrons that had survived the battle.

Already, I saw, the crews of those cruisers were taking their places within them, and as Macklin and Hilliard took up their positions in our own I strode on across the plaza toward the huge tower's base, in which were the headquarters of the First Air Chief. Passing challenging guards at its door, I passed through a few narrow, white-lit ante-rooms, and then had stepped into the great circular room that was his innermost office. The curving walls of that room were covered with panel after panel of instruments and switches, which controlled the vast electrical currents that rushed down from the electric-tower's tip and transformers to those motors in the city's base. Near the room's center was the battery of six great switches which controlled the city's direction of motion, moving it in any direction at will at slow and ponderous speed, the speed-control's gleaming knob beside them. And beyond the controls of the great air-city, there stood a great table-map of the world, upon which a myriad of red circles automatically showed the position of the world's air-cities.

Behind this table-map, as behind a desk, the First Air Chief was sitting as I entered, while around the panelled walls there moved a half-dozen black-jacketed attendants constantly watching and controlling the flow of current from the power-tower's tip to its motors. The First Air Chief, as I entered, motioned me silently to a metal seat before himself, at the great table-map's edge, and then for a moment contemplated me in silence, as though considering his words before speaking. Regarding me intently, he began.

"For a second time, Captain Brant," he was saying, "I have summoned you here to me, but this time alone, and with the two hundred and fifty remaining cruisers of our first four squadrons summoned also outside. You are wondering, no doubt, why I have done so.

"The victory we have gained is, as I said, but a respite. We know that the two great Federations, though beaten back with great losses will soon be launching another and a far greater attack upon us, one against which I think we cannot stand. From the European Federation to the east and from the Asiatic Federation to the west that mighty second attack will be loosed upon us, with some terrible new weapon or plan whose nature we cannot guess. For though hundreds of agents have been sent by us to all the European and Asiatic air-cities, months before the outbreak of this war even, they have been either captured and made away with, or have been able to report only that immense preparations of some sort are going in in those cities, in Berlin and Peking especially. And the rumors which have reached us through them indicate that whatever great new colossal weapon or thing they are devising at Berlin and Peking, it is one which, they boast, will enable them to sweep all our cities from the air in a single mighty attack.

"You see, then, that to wait for them to develop their great weapon or plan, to await this terrible attack without action, is but to pave the way for our own doom. We must strike out to halt them, to cripple or destroy their great secret plans, must strike at the European and Asiatic Federations both before they expect us. And that is why I have called you here to me. For it is my intention to launch a great raiding attack of our own at both Berlin and Peking. If we can strike a smashing blow at those two air-capitals, can damage or destroy the great military preparations within their arsenals, which must hold their great secret also, we shall have crippled, for the time being, their plans and shall have gained time for us to learn and counteract those plans. Even now our two hundred and fifty ships are ready and wait to start for Berlin, while from San Francisco a similar number will raid westward to Peking. And it is my order that you, Captain Brant, shall command this great raid eastward, for your conduct in the great battle of yesterday proves you worthy of the command. So soon after that battle, our enemies will never dream of our lesser forces attacking them, so now is your great chance to strike back at them, to flash across the Atlantic in a great surprise raid and strike down out of the night with all your power at the great air-capital of Berlin!"

CHAPTER IV

A Desperate Plan

FOR a moment, I think, I stood in stupefied silence as the meaning of the First Air Chief's breath-taking plan sank into my brain. Then I had snapped to sudden attention, saluting, my eyes shining. Yarnall was smiling, too.

"The plan is bold enough," he said, "but it means a chance to strike a terrific blow at our enemies, to cripple and perhaps destroy their great preparations that mean doom for us. The two hundred and fifty cruisers gathered here in the central plaza have been completely replenished with supplies and inspected while you slept, their magazines filled with heat-shells, their bomb-

slots with mighty heat-bombs. You can thus start at once, heading straight across the Atlantic toward the air-city of Berlin. And if you can reach it with your cruisers, under the cover of darkness and the unexpectedness of your coming, win through their great patrols and chains of air-forts, and reach the great air-capital, you will be able to strike a blow that may yet save us. I know, and you know, Captain Brant, what perils lie between your cruisers and their goal, but I need not speak of those perils and need not tell you what hopes depend upon your raid. I need only give you now a single order—to start at once!"

Five minutes later our two hundred and fifty cruisers, humming like a great swarm of bees, were rising up into the brilliance of the sky. My own cruiser leading, the familiar figures of Macklin and Hilliard again in the bridge-room beside me, I wondered momentarily if ever I was to return to New York. The mighty city floating there beneath us, its crowds now watching in wondering silence as we rose from it, its masses of buildings suspended there between earth and sky like a strange new galaxy of stars—it was home to me, and it was somberly enough that I watched it dropping now away from our ships.

Upward we rose, hovered, then shot toward the west, driving smoothly until the great mass that was New York had dropped out of sight behind us. Then as I spoke an order into the distance-phone our ships turned, circling widely to the south, and then moved eastward, out of sight of New York. It was a necessary maneuver, I knew, to make it appear that our cruisers had gone westward. Necessary because in New York's millions there were certain to be European spies who would have endeavored to warn their capital had they suspected that we were in reality racing eastward.

And now as we shot out over the Atlantic again, I gave another order and our two hundred and fifty cruisers massed quickly into a compact triangle with my own ship at its apex. It was the best formation for a raiding party, and holding to it our little fleet shot upward now and onward, onward until we were racing above the great line of our air-forts hanging miles out over the Atlantic in a great watchful chain. We had answered their challenge and were rushing on above and beyond them.

Within minutes they had vanished behind us, and our cruisers were rocketing forward at swiftly-mounting speed, racing onward and upward until at more than a thousand miles an hour we were rushing eight miles above the ocean's surface.

As we were rushing toward the east, as fast as the sun was rushing away from us, the night came upon us swiftly. There came dusk and then the stars. We were at an altitude at which we would be sighted by almost no other craft, I knew, an altitude rarely used by any ships. Though the modern closed-construction and air and heat arrangements of aircraft made flying at that height practicable enough, it was necessary by reason of the greater tenuity of the air to use more of the motors' power to attain the same speed. As we hummed on at that great height, all sight of the ocean beneath was hidden from us by the great vapor-layer that lay over it beneath us and only the pale stars above and the triangle of gleaming cruisers behind were visible to us. Yet as we shot on, it was not these, our immediate surroundings, that held my thoughts, but the object of our flight. Gazing beside into the night, with Macklin silent at the wheel beside me and with all our long ships rushing close behind, I could not but be aware in those moments of the desperateness of this raiding attack upon which we were engaged.

To flash across the sea with but little more than two hundred cruisers, to attempt a raid upon the European Federation's mighty capital even while a similar raid was made from westward upon the Asiatic Federation's capital, seemed indeed so desperate as to approach insanity. Berlin was guarded by a great chain of air-forts and patrols hanging over the eastern Atlantic; which held within itself, without doubt, all the great European battle-fleet of thousands of cruisers; which bore upon itself countless mighty batteries of giant heat-guns. Could we, in the face of these, reach Berlin, and send our heat-bombs crashing down upon its great arsenals?

Above the Enemy

THESE were the doubts that assailed me as our triangle of cruisers throbbed on and on through the upper night, but resolutely I thrust them away, remembering what our attack, what the crippling of our enemies' great and mysterious preparations, would mean to our American Federation. Then I turned as Macklin pointed silently to the glowing-figured dial of our distance-log, and saw by it that while I had brooded there at the window we had swept far out over the Atlantic at our tremendous speed. Within a short time, I knew, the European coasts would be beneath us, but during all the course of our flight so far we had sighted no other ships whatever, all merchant-traffic over the great ocean having been swept from the air by the first alarms of war, while we were still too far to the west to be meeting the far-flung patrols of the European Federation forces.

Soon, though, these would be coming into sight, I knew, and the result of our daring expedition depended upon our success in passing them unobserved If we were seen by them, a minute would suffice for the patrols to give the alarm by distance-phone, and then from all the European air-cities ahead, from Stockholm and London and Berlin and Marseilles and a hundred others, numberless patrol-cruisers would be swiftly converging upon us in answer to the alarm. And the European battle-fleet itself, we knew, in Berlin, the air-city we had come to attack, would be swift to answer also, so that never could we hope to win through if we were but for a moment detected.

But still we were rushing westward through the night, my cruiser in the lead, and still as Macklin and I peered intently ahead and below, Hilliard having taken up his station beneath, we could make out nothing but the chill masses of the great vapor-layer far beneath us, and the gleaming, rushing shapes of the cruisers behind us. Then, I peered ahead and down toward the right, with body tense, and in the next moment had snapped out the green guiding light at our cruiser's stern, and had uttered a quick order into the distance-phone before me.

"European Federation patrols ahead and beneath!" I warned quickly. "All cruisers reduce to quarter-speed!"

Instantly in obedience to that order the triangle of rushing ships behind was slowing, each cruiser swiftly reducing speed, the great drone of their motors dying to a steady hum. Moving forward thus, as slowly and silently as possible, I pointed downward, Macklin's eyes following my pointing finger.

"The patrols!" I whispered to him. "There beneath us—moving northward!"

Far beneath us indeed they were, a little circle of moving lights that hung just above the great vapor-layer and that was moving steadily toward the north, from our right to our left. Some twenty or more of those white lights there were, moving smoothly along in the same ring-like formation, and though we could not see the shapes of the cruisers from which those lights gleamed up through the night, we knew that they could be only one of the enemy's westward patrols, flying in the familiar European Federation circular formation. Watching them, Macklin and I unconsciously held our breath, while from our ship and from all the ships behind there came no sound other than the low hum of the motors. Slowly beneath those motors' lessened power our cruisers were moving forward through the upper darkness, while beneath the little ring of lights were still holding toward the north. Our presence far above them was apparently unsuspected by them.

I knew, though, that if they were to turn toward us by any chance the great cone-shaped cruiser-finders which are set in the sides of all war-cruisers and air-forts and air-cities, that we would be detected soon enough, since undoubtedly the patrol-ships beneath carried them also. Those great cone-like instruments, when turned in any direction can detect by means of super-sensitive induction-balances the operation of any electrostatic-motors. Fortune favored us, though, for without dreaming of our existence there above them the ring of patrol-cruisers, the circle of moving lights, moved smoothly on to the north while we held, eastward until they had vanished behind us.

Now as I spoke a swift order we were picking up speed again, our cruisers accelerating once more to their former velocity. I knew that we must be very near the southwestern coast of England. Our course lay high above that coast, taking us along a line that would lie midway between the two mighty air-cities of London and Paris, avoiding both purposely on our great flight toward the mightier air-city of Berlin. Soon, I knew, the great air-fort chain that guarded the whole western coasts of Europe would be drawing within sight, and intently enough we were peering forth in search of it, but though that must be passed still we had won through apparently, the outer patrols, without discovery.

"It's hardly likely that they'd have a second line of outer patrols out," I said to Macklin, as we peered together through the dim night from the bridge-room of the rushing ship. "And once we get past the air-forts we'll have a good chance."

He nodded. "They'll never dream of us making a raid upon them tonight, and if we aren't picked up by the air-forts' cruiser-finders we can reach—"

He broke off, suddenly, and at the same moment as he, I gazed down toward the right. Another ring of moving lights was there in the darkness beneath, northward, too. But this one had paused for a moment and was slanting straight up toward us!

"Another patrol!" Macklin's cry was echoed into the distance-phone.

Another patrol—and it had seen us! And then, even as that patrol's twenty cruisers slanted up toward us, to challenge us, eighty of the cruisers of the lowest of our great triangle of ships had whirled like light down toward them, without command or formation, whirled down upon them massed together like a great striking thunderbolt of gleaming metal! For they knew, without need of command, that in an instant more the patrol-cruisers beneath would see and recognize the purpose of all our racing ships, would instantly with their distance-phones send the alarm spreading like flame over all the European Federation. And so our eighty down-rushing cruisers, massed solidly together, fired no guns and dropped no bombs, but simply flashed downward in a terrific ramming swoop and in an instant more had crashed their great mass squarely into the ring of the uprising European ships!

There was a rending crash of metal that seemed to split the air beneath us, and then in a great shower of wrecked and twisted cruisers the ships beneath were falling, tumbling down and vanishing into the vapors far beneath on their headlong fall toward the Atlantic! All of the twenty enemy cruisers, and about twenty-five of our own four-score that had crashed down into them, fell thus, annihilated almost by that terrific collision. It had been the one means, though, of instantly destroying their patrols without using our heat-guns whose detonations might give the alarm. And we knew that only that swift, unordered action on the part of our lowest ships had saved us. Then the fifty-five survivors had rushed up again among us, and then our ships that had slowed there for the moment were rushing still on eastward.

The Air-Forts

ONWARD we shot through the upper night, shaken still by that sudden peril and escape, and then I uttered a warning word into the distance-phone from our cruiser leading. For now, far ahead, we could make out great beams of white light that hung in a great row extended from north to south as far as the eye could reach, and that seemed like white fingers of light whirling and reaching through the air as they ceaselessly swung and circled. A full four miles above the earth, and more than that beneath the level of our own onrushing ships, hung this great line of restless beams, and we knew it, at once, for the great line of air-forts that guarded the western approaches of the European Federation. For the beams we saw were the great beams of the air-forts' mighty searchlights, and those swinging shafts of radiance were of such intense brilliance and magnitude that even at our greatest flying height we could not hope to pass over them undetected.

It seemed, indeed, that to pass them was hopeless, since the air-forts, hanging above the great layer of misty vapor that stretched beneath, could instantly detect with those mighty beams any cruisers passing above them, at whatever height, and could blast them from the air with their gigantic batteries of heat-guns. To pass beneath the great vapor-layer was as impossible, since the air-fort chain which the European Federation put forth here in war-time was a double one, and its second line hung, farther eastward a little, beneath the vapor area, watching with its own great beams and guns for any ships passing there. There remained but one alternative, to pass through the thick mists of the vapor-layer itself, but that, though concealing us from the guns of air-forts above and beneath, would be in itself suicide, since such vapor-layers between the forts were invariably filled in war-time with floating air-mines, great cube-like metal containers held aloft and motionless by their own electrostatic-motors and tube-propellers and which contained a terrific heat-charge which was instantly released upon any luckless ship that touched them.

But now as our ships slowed at sight of the ominous

fingers of light far ahead I spoke quickly into the distance-phone. "Our one chance is to go through the vapor-layer," I said, "and use our cruiser-finders to avoid the air-mines. By going through in a three-ship column we may be able to make it."

At my order therefore our great triangle of cruisers shifted its formation abruptly into one of a long slender line, three ships in width, and then that line with my own cruiser at its head was slanting sharply downward toward the great mists beneath us. A moment more and our cruisers had entered those mists, were moving forward enveloped in them, the great vapor-layer through which we moved hiding all things from about us, hiding our cruisers even from each other. But though we could not see them, we knew that the great air-forts hovered ahead and above us, now, and that the vapor-layer into which we were moving was one sown thick with the deadly air-mines. So, with Macklin at the cruiser's wheel guiding it slowly forward at the head of our column of ships, holding a course eastward through the mists by the compass and creeping forward now at the same low speed as the ships behind, I ordered Hilliard, beneath, to swing out the cone-like cruiser-finders from our ship's sides, and to report instantly any air-mines they detected before us.

Behind us, too, the cruisers that followed were using their own cruiser-finders as they crept through the mists after us, at my order; for though as leading ship we could report to them all air-mines which we encountered before us, it was necessary for the cruisers behind to feel their way forward independently, since in the concealing mists they could not follow exactly upon our own ship's track. Now, though, listening intently at the order-phone, I waited Hilliard's reports. And in moments more, as our cruiser-finders' coils picked up the hum of the enemy's electrostatic-motors a little ahead and to the right, he reported sharply and I repeated the information swiftly to Macklin, who instantly swung our ship a little to the left. And still Hilliard remained with the cruiser-finders, whose supersensitive coils caught instantly the electrostatic-motors of the air-mines before and about us.

Onward thus we crept, Hilliard reporting at intervals of every few moments as an air-mine was picked up ahead, while at my swift repetition of his report Macklin would swerve our ship to avoid it. Behind our own craft, we knew, all the scores of our cruisers were creeping forward through the great vapor-layer in the same manner. Now we could plainly hear the great, unceasing drone of the mighty air-forts above, as we crept through the vapor-layer beneath them, and knew that were we to emerge into any chance opening in the thick mists about us we would have but short shrift enough from the giant guns of those forts overhead. Yet still we crept on, praying that none of our cruisers struck the deadly mines, since a single one striking would loose a great flare of heat and light from the bursting air-mine that would betray us all. Even our own ship, as it swerved from an air-mine that Hilliard had hastily reported, almost ran full onto another one in the opposite direction, a great cube of metal, holding within it a hell of condensed heat and death and suspended by its power gained from the concentrated cosmic trap. And though Macklin whirled our cruiser aside in time to graze by it it seemed impossible that all our ships could feel through this field of death without disaster.

Yet still we were creeping onward, through the thick mists, and now the great air-forts' drone came from behind and above us, as we passed on beneath them. On and on, feeling blindly forward through that zone of potential death we went, over the second chain of air-forts whose motors' sound came up to us muffled through the mists, and then that too was dropping behind us. For some moments, though, we continued to feel forward in the vapor-layer, and then I had given the ships behind the order to rise and at once, as carefully as ever, our cruisers were feeling their way upward until they emerged at last into the open air above the mists, a tight steel hand seeming to unclose from about my heart as we came up from out that terrible zone of death into the dim starlight of the upper night, the white beams of the upper air-forts now far behind us.

On to Berlin

"THROUGH at last!" I cried to Macklin, as we drove upward. "It seems incredible that all our ships could have won through that mine-field!"

Macklin nodded. "We'd not have made it had the air-forts there been using their own cruiser-finders," he said. "But they never dreamed that any ships would try to get through the mine-sown mists, evidently."

Now I spoke into the distance-phone another order, and our ships were swiftly forming into their triangle formation, were racing forward again at rapidly mounting speed to the east, air-forts and deadly mines and questing outer patrols out of sight. And now, as with Macklin and Hilliard, who had joined us from beneath after his work with the cruiser-finders, I gazed forth, I could see that the great layer of mists beneath us was thinning somewhat as we raced on, knew from that fact that we had raced from above the Atlantic and now were moving far above land, since always these mist-layers were far denser above the sea than above land. That land over which we were now speeding could only be that of southwestern England, I knew, and even now our flashing triangle of cruisers was veering further to the south to avoid the great air-city of London. Then, as we hummed on eastward at the same great height as before, we made out a great mass of lights far to the north, a mass of white lights that hung high above the earth and that glowed toward us like a single soft light through the mists that lay between it and our eastward racing ships, smaller beams stabbing and circling from it.

There were needed not the exclamations of Macklin and Hilliard beside me to inform me of that great light-mass' identity, for an air-city of that size in this region could be but London. The great city, I judged, had moved eastward somewhat from its usual position over the center of southern England and further away from the great chain of air-forts and mine-fields that guarded it to the west. It was not London, though, that was our flying force's objective on this night, and we raced onward with no backward glances toward it, peering ahead with growing tenseness. Far below us we could glimpse, now and then, occasional formations of merchant-ships flying toward or away from London, and convoyed usually by a half-dozen war-cruisers, but these were far beneath and as we were showing no lights and rushing on at tremendous speed they did not glimpse us.

No patrols were in evidence now about us, the main reliance of the European Federation air-chiefs having apparently been put upon their great outer circle of air-forts and patrols, through which we had managed

10,000 YEARS HENCE

A Prediction

This illustration reproduced from the magazine *SCIENCE AND INVENTION* of February, 1922, shows a city 10,000 years hence as conceived by Hugo Gernsback, and based on a prediction of Captain Lawson of aerial fame. The city the size of New York will float several miles above the surface of the earth, where the air is cleaner and purer and free from disease carrying bacteria. Gravity-nullifying devices were pictured as the means of keeping these cities suspended. Four gigantic generators will shoot earthward electric rays which by reaction on the earth produce the force to keep the city aloft. By increasing or decreasing the electrical energy the city may be raised or lowered as desired. The city is roofed over by a substance which is transparent, strong and unbreakable. The atmospheric pressure within the city will probably be four or five pounds per square inch instead of 14.7, as it now is. Possibly, therefore, future men will have larger chests than we do. Furthermore, by rising above the clouds we will be freed from rain, snow and thunder showers. We will have in fact perpetual sunlight. The city will derive its energy from the sun, the solar energy being converted into electrical energy.

to break. Nor, was it evident, did they dream that the American Federation, depleted as its fleets were despite their victories in the battles of the day before, would attempt any such daring attack upon an enemy so superior as we were rushing upon now.

As we fled onward, holding our three-sided formation, I wondered momentarily what that other American force was now doing that was heading in the same way toward Peking, and then my wonder passed as another great glow of white light showed itself ahead and to the south. It was Paris, we knew, a great air-city as large as London and outranked in size only by the three colossal air-capitals of the world. But it was not Paris, either, that was our goal, and we veered now to the north somewhat to avoid it, flying on at such a great height and distance from it as to pass far beyond the reach of the great searchlight beams that swung and circled from it as they had done from London. Then it too had dropped behind to the south, and regardless now of the other air-cities that we glimpsed far off in the night, we were rushing eastward high above what had once been France, were speeding forward at the same tremendous height on the last lap of our daring journey.

Now other masses of air traffic were manifesting themselves far beneath us, as squadrons of moving lights, but neither Macklin nor Hilliard nor I, nor any in our ships, were paying attention to these, all our souls centered on the horizon ahead, on the dim darkness of night that stretched before us. Gazing out into that darkness, my two friends beside me, as tense as I leaned, there at the bridge-room's windows as our droning flight of ships sped on. Nothing dispelled that darkness but the dim starlight from above, but now, as we gazed forth, we became aware of a faint light coming feebly toward us from far ahead, a faint light that seemed like a great, feebly-glowing cloud in the darkness, and that was intensifying in radiance with each moment that we rushed toward it. The glowing cloud seemed to sink steadily as we sped on, seeming to become lower until from our own ten-mile height we saw at last that it was hanging at a height of four miles from the earth. And swiftly it was growing in size, ahead and beneath us, until as we neared it high above, it changed suddenly to our eyes from a great glowing cloud of light to a colossal circle of upflushing white radiance, a mighty circular city floating there in midair, that was as huge as New York itself, and that blazed in the night before us as our own city was wont to blaze.

"Berlin!"

Our three exclamations came together in that moment, exclamations that must have been echoed then from every watcher in our onrushing ships. Berlin! In all its stupendous, radiant splendor it hung before and beneath us, the mighty air-city that was the European Federation's capital and center, equalled in size only by New York and Peking. There between earth and stars it floated, its white-lit towers soaring up from the mighty metal base, all out-topped by the slender central pinnacle that was the great city's electrostatic-tower which drew from earth's charge its electric power. Around the city's edge there stabbed and circled the giant white beams of its great searchlights, sweeping to and fro over the still-thronged streets, in which we knew there surged the crowding masses of the great air-city's population. And high above these, moving restlessly to and fro, there came and went the great network of patrols which guarded the great metropolis of the air on all sides.

But our own ships, winging more slowly on at our tremendous height, were never glimpsed by the patrols so far beneath us, never caught at our great height by the great white beams that came and went below, and that only occasionally clove the night above. And as my order brought our ships to a halt, we could make out more details in the white-lit city floating far beneath us. Could make out, as we hung there motionless, the great batteries of pivoted heat-guns set at the central plaza and all around the city's encircling wall, the great square metal buildings of the arsenals, in two groups at the city's east and western edges, the central headquarters and arsenals of all the European Federation's military forces. On the plazas around those buildings rested long ranks of gleaming cruisers, cruisers that numbered thousands and, we knew, were those with whom we had battled so furiously over and in the Atlantic a day before. And it was down toward these buildings and these cruisers that we gazed now, in that moment before the city's cruiser-finders beneath could detect us and spread the alarm.

"The cruisers and military buildings and arsenals below will be our main objective," I said into the distance-phone as we hung there in that tense moment, above the shining city. "The city's electrostatic tower is so closely defended by heat-gun batteries that we could never get near it, and like all power-towers of air-cities it's of metal alloys that the heat of our shells and bombs wouldn't affect, so we can't hope to destroy it and thus crash the city to earth by cutting off its sustaining flow of power. Our goal must be the cruisers and arsenals, and we'll attack them in two great swoops, the eastern ones first and then the western, and if all goes well can then swiftly escape before the forces below can gather and rise against us!"

A Sudden Attack

NOW, poised there miles above the great air-city, which was itself poised high over the earth, our great triangle of ships hung like so many birds of prey for the moment. Beside me Macklin was gazing downward as tensely as myself, Hilliard beneath with our waiting gunners, while under my fingers lay the four rows of white buttons the pressing of each of which would release from our cruiser's bomb-slots a portion of the immense heat-bombs they held. Poising there in that tense moment the whole scene was imprinted unforgettably upon my brain—the gloom of night about us, the vast radiant circle of the colossal air-city beneath, the patrols swarming over it, the throngs that filled its streets, excited no doubt over the beginning of the long-expected war that was to annihilate the American Federation. Then I spoke one sharp order into the distance-phone and instantly with all our motors droning suddenly loud our great triangle of cruisers was diving straight downward upon the radiant air-city beneath!

Down we shot with dizzying speed in that mighty swoop, down with my own cruiser flashing foremost and with all our others close behind it, down through miles of space in a flashing moment, it seemed, until our hurtling wedge of ships had crashed down into and through the swarming patrols above the city, had driven like light down through them toward the eastern mass of military structures and cruisers that was our goal! From all of our ships no single gun sounded nor from the patrol-cruisers through which we dropped,

so stunned were they by our great crash downward through them. It was as though for that moment a tense silence had been enforced upon all the world, a silence broken only by the drone of our motors as we plunged. Then I was aware in a swift succession of flashing impressions of the white-lit city's towers and buildings rushing like light up toward us, of the great square military arsenals and buildings with the gleaming ranks of cruisers about them, just beneath us. Then as we plunged to within a half-mile of those buildings and cruisers my own foremost-flashing cruiser curved forward and, as our down-plunging ships levelled out behind it, I pressed swiftly a row of the buttons beneath my fingers. The next moment our cruiser was swaying from side to side as it rushed on, and down from it and from all the massed ships behind and about us were plunging thousands of giant, cylindrical heat-bombs!

Even before those heat-bombs struck, our onrushing ships had curved like lightning upward again, but the next moment were reeling and tossing even in the mad upward rush as from beneath came a titanic merged flare of all the bursting heat-bombs, from which an awful wave of super-heated air rushed up and overtook us, and beneath whose terrific released heat dozens of the huge military buildings beneath had fused and melted. We could glimpse, too, that below a full half thousand or more of the resting cruisers had perished also in that giant flare, and that it was as though a whole great area of the gigantic air-city beneath us had been transformed suddenly by the released heat of our mighty bombs into a huge crater of white-hot, melting metal near the floating city's edge! And from all across the mighty white-lit mass of Berlin, that had reeled itself in mid-air from that terrific blow, there rose a dull, roaring clamor of millions of voices that came up to us even over the drone of our great motors and the rush of winds about us!

Upward at utmost speed we were rushing, and just in time for hardly had o u r heat-bombs struck when, despite the utter unexpectedness of our attack, the great batteries of heat-guns around the central electrostatic tower that guarded it were wheeling toward us and thundering as they shot a storm of heat-shells above the white-lit city toward us. Even as I had said, those vigilant watchers at the power-tower would have blasted our fleet from the air before we could have ever got near to the tower itself, but as it was we had struck a terrific blow at the military arsenals and the resting fleet, and had flashed upward again in time to escape the blasting guns at the city's center. But now, through the night above the vast roaring city, the batteries all around its rim were swinging their pivoted guns toward us and sending a hail of shells after us while, as all the city's great searchlights wheeled their beams madly through the air toward us, the swarming patrols all around us had recovered from their stunned astonishment and were leaping also toward us!

"One more attack!" over the uproar I was yelling into our distance-phone as we shot upward through that mad chaos of whirling beams and ships and shells. "The city's western arsenals this time—loose the other half of our bombs on them!"

Holding still to our triangular formation in that wild mélange of sight and sound, our ships levelled out once more, high above the city again now, and with only a scant dozen having been reached by the hail of heat-shells that had rushed after us from beneath. Then we were speeding westward over the tremendous city, high above it, scorning to stop for the swarms of patrol-cruisers that were dashing toward us. Those cruisers were rushing with suicidal fury toward us with every heat-gun detonating, but our own gunners were plying our batteries even as we dashed forward above the air-city, and on all sides of us the patrol-craft were flaring and fusing and crashing down toward the city beneath! Here high over the city, though, the shells of all the heat-guns that now were booming toward us could not reach us, and through battling ships and whirling beams and gloom of night we rushed westward over the giant air-city until in a moment more we were pausing over the western arsenals, and the western plaza where rested other massed cruisers of the great European battle-fleet. And then as I gave another order we were diving once more, down toward those buildings and cruisers!

The Second Blow

THIS time, though, all the colossal city beneath us was roused and roaring with fury as we shot downward, and from beneath there slanted up toward us a terrific hail of shining heat-shells from all the city's great batteries. Eastward the cruisers that had escaped our bombs there were rising and forming to attack us, while, even as we shot down, the cruisers beneath were rising and flinging themselves to one side for the moment to escape our swooping rush and bombs. But through storming shells and blinding beams we shot again on our terrific dive, until in another moment our fleet was levelling again above them and as Macklin drove our cruiser level before the rest I had pressed the remaining buttons, had sent our remaining heat-bombs whirling downward with those of all the ships about me! And then as our ships curved upward again, our terrific blow struck, the bombs were finding their mark again, were flaring and fusing with terrific heat and power into another giant mass of melting metal and awful heat there at the city's western edge.

And now, bombs gone, our cruisers were whirling upward now to escape from the great city we had struck such two awful blows, to head westward again over the Atlantic. About us a wild hail of heat-shells from the guns beneath were rushing upward and dozens of our cruisers were flaring and falling before we could gain a height again that put us beyond reach of the batteries beneath. Then we paused a moment, massing again to head westward, with only a few patrol-cruisers dashing futilely toward us from about and above us, now. Beneath us the giant air-city of Berlin lay with two white-hot craters of fusing metal glowing near its eastern and western edges amid the brilliance of its myriad lights, the great city hanging still in mid-air with the great motors in its base untouched by our two awful blows. Through its streets were rushing panic-mad crowds, and over it were rising the cruisers of its battle-fleet, striving to form and follow us as the guns thundered madly toward us and the searchlights wildly stabbed and circled.

But as we hung there for that moment, massing together again, a wild triumphant cheer was coming from all in our cruiser and all the cruisers of our mass. For we had lost but a few dozens of our ships and had all but destroyed the mighty Berlin arsenals and a thousand of the European Federation cruisers, had struck a staggering blow at our enemy. And even as we gathered now we knew that the cruisers rising from beneath, striving to form their shattered and disorgan-

ized and stunned squadrons, would be too late to pursue us. Westward lights were gleaming in the upper air, growing larger, and we knew them to be other patrol-cruisers rushing in answer to the alarm from the city beneath, knew that even at that moment the great air-forts hanging in a chain westward would be rushing back to defend Berlin, knew that easily we could evade them and with their great chain broken could head westward at full speed over the Atlantic and win back to our own land. We had succeeded in our daring, insane plan, and our cheers were rolling out still as we began to move westward above the great, panic-roaring air-city.

"We did it!" I cried to Macklin as our cruisers leapt forward now. "We struck a blow this time that they never dreamed we had the power to strike!"

"And we'll win clear!" Macklin exclaimed, as he sent our cruiser shooting forward at the head of the others. And Hilliard, bursting up into the bridge-room from beneath, was crying, "We made it, Brant—we've destroyed their arsenals and a fourth of their fleet!"

"And now back westward!" I exclaimed as our cruiser shot ahead. "Now back—*but look there above us!*"

My words had changed suddenly into that wild cry of warning, and as the others glanced up they saw above that which had brought that cry from me. Two of the patrol-cruisers of the enemy that were dashing about us still in futile attack as we started away had drawn back and had circled upward high above us. And now, without using heat-guns and for that reason not detected by us until that last moment, they had joined together and side by side were rushing straight down upon us like a great single projectile of flying metal! Were rushing straight down toward our cruiser, that sped in front of all the mass of our cruisers, identifying it in that way as the ship of our expedition's commander, and sacrificing themselves to destroy us in a headlong crash in revenge for our bombing of the city beneath! Even as I had glimpsed them, had cried out, they were looming just above us, rushing down toward us!

Even as that wild cry had left my lips and as the others had looked up other cries had come from them, from Macklin and Hilliard. *"Over!"* I screamed to Macklin as his hands shot to the wheel, and in the next instant he was whirling the wheel over, to send our cruiser whirling sidewise to escape that thunderbolt of twin destruction from above. But in the next moment, before it could answer to the wheel, the down-thundering ships above had crashed squarely down into our own! We reeled there with them for a single instant, three twisted wrecks of metal hanging there in mid-air in that instant, and then theirs and our own wrecked cruiser were falling, were hurtling crazily downward through the upper night toward the giant radiant circle of the great air-city miles below!

CHAPTER V

Captured

THAT mad whirl downward of our wrecked cruiser is now to me more of a memory of some strange and torturing dream than a memory of actual happenings. Flung sidewise and downward against the bridge-room's floor as our cruiser whirled over with that mighty crash from above, I glimpsed Macklin and Hilliard tossed about there with me, rolling over and over. The black gloom of night about us, the mass of our onrushing ships above, the colossal brilliant air-city beneath, the two wrecked cruisers that were tumbling downward with our own—all these things seemed to whirl about us like some great wheel of swift-succeeding impressions as we glimpsed them in that mad moment through the bridge-room's whirling windows.

It seemed but a single brief moment before I glimpsed the great mass of lights, the soaring towers, of the air-city beneath rushing up toward us with unearthly speed. Even as I glimpsed it another turn of the spinning ship had thrown Macklin and Hilliard over again, and this time I clutched for a hold, found one upon the cruiser's wheel. Then, with the droning of the still-operating motors and the cries of my two companions and of the crew beneath loud in my ears, I reached with a great effort toward the control of the motors, clinging to my hold with a supreme effort. My fingers found that control, but at the moment they did so I heard a last hoarse cry from Macklin, glimpsed but yards beneath us, it seemed, the smooth surface of one of the city's narrow streets, and then flung over the control, shifting all the power of the motors from our horizontal tube-propellers to our vertical ones. The next moment a blaze of light seemed all about us, there was a terrific crash, and as I was hurled back across the bridge-room by the impact, my head met the metal wall of it and consciousness left me.

When I came to it was to the realization of someone's hands endeavoring to revive me, I opened my eyes to find myself lying on a long seat of metal, with above me the metal ceiling of a white-lit room, and with Macklin and Hilliard bending anxiously over me. I strove to speak to them, desisted as my first movement made apparent to me a painful swelling on the side of my head. And then with their helping arms behind my back I sat up, looked dazedly about me. Then, the memory of what had happened rushed suddenly back upon me and I was filled with an abrupt dismay.

For the white-lit room in which I sat, seeming an ante-room to other chambers beyond, held beside us three a half-dozen of men in the green, tight-fitting uniforms of the European Federation's forces, alike save in colour to our own black uniforms. They were ranged before us, watching us closely, and there swung at the belt of each a shining, long-barrelled heat-pistol, one of those hand-weapons that throw heat-cartridges smaller than the great heat-shells and bombs, but as destructive and deadly on a smaller scale. These six European Federation soldiers had their heat-pistols ready beneath their hands, and were contemplating us intently. And as I saw that, and glimpsed also through the open door to the right of us a great, smooth-floored plaza and immense buildings towering up into the outside night, brilliant with lights, and heard the roar of the crowds that seethed among those buildings, I remembered all that had befallen us, clutched Macklin's arm tightly.

"The cruiser fell!" I exclaimed. "I remember the crash, now—then this is Berlin, Macklin, and we're captured!"

"Captured," Macklin quietly said. "You and Hilliard and I were the only ones to survive our cruiser's crash, Brant—and we survived only because we were in the ship's bridge-room, its upmost part, when it crashed. You had been stunned, and before Hilliard and I could recover from that crash the European guards had swarmed up over the wreck and captured

us, taking us here to the great central electrostatic tower."

"We three the only survivors?" I repeated. "Then —then all our crew—?"

Macklin did not answer, but as his eyes held mine I read my answer in them, and as I did so something hard seemed to form in my throat. Our crew—the hundred cheery lads that had manned my cruiser for long, and each of whom I had known by name—and all annihilated in that great crash downward which we three in the bridge-room had alone escaped. I felt Macklin's understanding grip on my shoulder, and then we were suddenly recalled to realization of our position as a door in the ante-room's left side clicked open, another green-uniformed figure emerging from within. He spoke a brief order to our guards in the European tongue, that Latin-Teutonic combination of languages which was universal throughout the European Federation and which I myself spoke and understood to some extent. Instantly our guards motioned us to the door from which the other had emerged, and as we passed through that door before them we found ourselves in a larger and circular room, white-lit like the first.

It was, I saw instantly, the central control-room of the great power-tower, of the whole great air-city of Berlin. Like the similar control-room in the power-tower of New York it held on its walls panel upon panel of dials and gleaming-knobbed switches, while at the center of the room were also six great controls that directed the great air-city's movements through the air in any direction, and the single power or speed control. Beside these was another great raised table-map, this one mounted upon a solid block of metal, with upon it the red circles of the world's air-cities. And beside that map there sat now a dozen or more men in the same green uniform as our guards, though with metal wing-like insignia upon their sleeves. They were, I knew without asking, the highest Air Chiefs and officers of all the European Federation, gathered here in the control-room of that Federation's capital city.

The Captors' Threat

FOR a moment we three faced them in silence, our guards watchful still behind us, and then the center-most of the seated figures, a swarthy, black-haired officer with black, probing eyes, whose five metal wing-insignia marked him as the First Air Chief of the European forces, spoke to us, in our own tongue.

"You are Captain, First Officer and Second Officer of the American Federation cruiser which crashed in our streets just as the main body of your ships escaped," he said, and even at the words my heart raced with sudden gladness. Our ships had escaped safely back over the Atlantic, then, as I had known they would! "——and we desire to know," the European First Air Chief was continuing, "just what forces remain to the Americans and which engaged in this attack."

I faced him in utter silence, my own eyes meeting his probing black ones calmly, and at my silence I saw a contraction of the muscles about those eyes, a sudden flush beneath his swarthy skin.

"I think it would be best for you to answer," he said quietly, "nor need you think that silence will help your countrymen in any way. For though your cruisers struck a great blow at us here in Berlin this night, though word has reached me that as great a one was struck by other American ships at Peking, these are but two of the two hundred great air-cities of our two Federations, but a fraction of our great forces. And we know that your fleets lost many ships in the battles of yesterday despite their victories, and desire to know what forces are left them."

Still in stony silence I stood, my eyes meeting squarely the eyes of the men before me, while beside me Macklin and Hilliard stood in the same stiff silence. I saw the European Commander's flush of anger deepen, saw him half-rise with hand clenched to hurl an order at our guards, and then he had relaxed back into his seat, was smiling grimly.

"A most unwise course to follow, Captain, you may believe me. I take it that your officers are as mule-headed? Well, there is no immediate hurry and a few days of consideration, of meditation, may change your minds. As a subject for your meditations, you may take my promise to you that unless you become more communicative at the end of the fortnight I give you, we shall be forced to use somewhat unpleasant procedures with you. An earnest consideration of that fact will, I think, change your viewpoint somewhat."

He turned, snapped an order in his own tongue to the captain of the guards behind us. "A cell in the one hundredth story for these three—put them with the other American, and if after a fortnight they're still stubborn, we'll deal with all four."

Immediately our guards had marched us back to the door through which we had entered, and across the ante-room beyond through another door and into a short, broad hall along the sides of which rested the great tower's lift-cages. We were ordered into one of the cages, our guards holding their heat-pistols full upon us now, and then as a stud was pressed and the motors' power was turned through the cage's powerful vertical tube-propellers, those tube-propellers drove us up with a thin whistling of air up through the narrow shaft the cages moved in, up until in a moment more we had stopped and were emerging into a similar hall on the great tower's hundredth floor. From that hall we moved into a short corridor that ran the width of the great tower, which at this height was but a hundred or more feet in diameter, its slender pinnacle tapering as it rose to its tip, while much of that pinnacle's space was occupied by the great connections which carried the city's electrical power down from the mighty tower's tip.

Along that corridor we went, one lined with solid metal doors on either side, and finally were halted before one of those doors. Then one of our guards drew from a pocket a small instrument resembling an electric torch, from which he flashed a tiny beam into a transparent-fronted little opening in the wall beside the door. At once there came a clicking of locks, and the door swung open, its locks unbolted by the beam of light or force, rather, whose vibratory rate was exactly tuned to affect a delicate receiver tuned to the same frequency, set in the wall and controlling the lock. These vibration-locks, indeed, had long ago replaced the old, clumsy keys, and were far safer in that they responded only to one certain frequency vibration out of the millions possible, and thus could be opened only by one who knew the correct frequency. Now, as the door swung open, our guards pointed inside with their heat-pistols and perforce we stepped within, the door snapping shut behind us.

We found ourselves in a small, metal-walled cell some ten feet in length and half that in width, furnished with but a few metal bunk-racks swung from the

walls. At its farther end from us was the only opening beside the door, a small square window that was quite open and unbarred, and that looked out over all the colossal mass of the great air-city of Berlin, a giant field of blazing lights stretching far around and beneath the great tower in which we were prisoned. Then, as we gazed about the little cell with our eyes becoming accustomed to its lack of light, we made out suddenly a figure standing near its window, a dark, erect figure who seemed watching us for the moment and who then was striding across the cell toward us.

"Brant!" he exclaimed, as his eyes made out our faces through the dusk. "Brant—and you were with the ships that attacked the city but now—you were captured in some way!"

But now my own eyes had penetrated the dusk enough to recognize the features of the man who was gripping my arms, the keen, daredevil countenance that I remembered at once.

"Connell!" I cried. "You prisoned here! Then you're the other American the European First Air Chief ordered us prisoned with. But I had thought you dead!"

"Dead I might be as well as here," said Connell, suddenly somber. "For four weeks I have been here, Brant—for weeks before the beginning of this war. And now that this war has begun I, who alone might save our American Federation from annihilation in it, am prisoned here with only death awaiting me, and that in a few days."

I stared at him, astonished. Connell had been one of the cruiser captains of the American Federation forces for several years, and had been a friend of my own in those years. A year before he had withdrawn from active duty, no one knew to where, and finally, but a few weeks before the breaking forth of this war, our First Air Chief had told us in answer to our queries that Connell had been sent upon a special mission, but that since he had not reported for several weeks he had undoubtedly met death in the course of it. To meet him here, in the heart of Berlin and prisoned with ourselves, astounded me, and the more so since from his first words we understood that he had been confined thus for weeks even before war had burst upon us. But now, motioning us to seats on the bunk-racks beside us, Connell was questioning us eagerly as to the course of the combat between the great Federations so far, and his eyes shone when we described to him that terrific battle over and in the Atlantic that we had fought but a day before, and that daring attack on Berlin that he had himself witnessed from his window.

"I saw the European Federation's fleet massing and sailing westward yesterday," he said, "and knew it was launching its great attack, knew when it returned disorganized and shattered that the American fleet had beaten back that attack. But I did not expect this attack you made on Berlin tonight, and was as astounded as all in the city when you swooped down with your great bombs. A great blow, Brant—a great and successful blow against the whole European Federation, yet such a blow alone cannot halt the menace which it and the Asiatic Federation are preparing to loose upon our own nation. Such a blow, nor a hundred such blows, would avail but little in the end against the stupendous plans and forces that are preparing and massing even now to roll out upon the American Federation in an avalanche of doom!"

A Strange Tale

HE PAUSED, and in the dusky cell Macklin and Hilliard and I sat as silent as himself, gazing toward him in sudden startled surprise. From far out over the great air-city about us came the droning of rushing ships and the dim roar of voices from beneath. But Connell was speaking again—

"You, nor anyone else, knew where I went when I left active service in our fleet, none but the first Air Chief, who sent me. That was a year ago, and he told me then that it was evident that the European and Asiatic Federations were preparing to attack us, and that rumors had been heard of some mighty new weapon or plan with which, if their ordinary forces failed, they would completely crush us. Hundreds of agents, said the First Air Chief, were being sent to the European and Asiatic air-cities to try to learn the nature of this new weapon, and I was one of those to be sent to Berlin, as I knew the European tongue thoroughly. I was to go in disguise, was to endeavor to work myself into the European Federation fleet, and was then to risk everything in an effort to find out what this great new plan or weapon was. And so in disguise, a year ago, I came here.

"Eight months it took me to work my way into the European fleet, eight months in which I was chiefly occupied in establishing my new false identity as a European citizen. Then I enlisted in the fleet, entering the motor-section. Of course, as a cruiser-captain in our own fleet, all types of motors were perfectly familiar to me, and I had no difficulty in swiftly rising through various promotions to the status of under-officer in one of the European cruisers. Then came at last the opportunity for which I had waited for months, and which I had begun to despair of ever occurring. I was ordered to report back from my cruiser to the First Air Chief's headquarters here in Berlin, and when I did report I was questioned by a board of a half-dozen European officers on my knowledge of motors and tube-propellers. It must have seemed to them that I had unusual ability and knowledge for a mere under-officer, for they informed me that I had proved satisfactory and that I had been selected to form one of the workers on a great new work that was being carried out secretly, and ordered me to report to a certain compartment in the great air-city's base.

"I reported there, eager now as I sensed myself on the trail of that which I sought, and found that there were whole vast compartments in the city's great base in which only selected men and certain high officers of the European fleet were permitted to venture. These were the compartments in which were placed the giant tube-propellers which are set horizontally in the great air-city's base, and which when the power of its great motors is turned into them move the city in any desired direction. Every air-city in the world has, as you know, these great tube-propellers that move it about. But as you know too, so much of the motors' power must be used in the life of the city, that the horizontal tube-propeller can only move the great cities through the air at an extremely slow rate of speed. It is a predicament which cannot be altered, either, by adding more motors, since to add them you must add to the city's size, and so the problem remains the same.

"But now, as I found when I first entered those compartments, these European Federation officers and inventors had solved that problem! They had devised a way that would enable them to send their gigantic

air-cities rushing through the air at almost the speed of a cruiser itself! They had done this by devising a wholly new form of horizontal tube-propeller capable of infinitely greater tractive effect on the air and rotating at a much higher rate of speed. Thus the great air cities, miles across and with all their towers upon them, could rush through the air at hundreds of miles an hour, needing only to use their vertical tubes when they were hovering motionless in mid-air or were moving very slowly.

"And *this* was the great weapon, the great plan, of the European and Asiatic Federations! For I saw at once that it was a great weapon indeed, a terrific weapon which would enable them to annihilate all the air-cities and peoples of our own nation. You see what it meant? It meant that they could gather together all their scores of giant air-cities, outnumbering our own one hundred cities by two to one, and could rush over the oceans at awful speed toward our American air-cities, could fall upon them with all the giant batteries of heat-guns with which each colossal city is equipped, like our own. And because our own would not be able to move at that tremendous speed, because our own air-cities could only move at a comparatively creeping rate through the air, they would be able to mass their outnumbering forces around our own cities and blast them from the air, annihilating them and all the millions of our people inside them, sending them hurtling to earth in titanic fusing wrecks!

"To rush forth to battle, to the annihilation of our own cities, in their great air-cities! To send those gigantic cities of the air, Berlin and Peking and Tokio and all the scores of others of the two great Federations, thundering through the air to battle, each with its masses of towers on it. They have made provision for all people who are not entirely engaged in battle, to descend to the earth and remain there in specially constructed buildings. This will help also to reduce the weight of the cities. That was their great plan, their great weapon, and I knew that with it, even as they said, they could burst forth and annihilate our own air-cities. But, holding still to my work there in the lower compartments, I strove to penetrate the heart of the secret, the design of the great new horizontal tube-propellers which were to accomplish this, to send the mighty cities rushing through the air at such immense speed. Each of the great air-cities of the European and Asiatic Federations, as I learned, was being secretly equipped with these new tube-propellers, and I knew that if I could learn their secret, could take that secret back with me, our own American air-cities could be equipped with the new tubes likewise and could meet the attacking cities at equal speed, on equal terms, even though outnumbered.

The Great Danger

"SO I endeavored in every way to penetrate the secret of the new tubes, to ascertain their construction, which was jealously guarded by the European and Asiatic Air Chiefs. And at last, hardly a month ago, I did that, was able to make my way from my own work to one of the great tube-propellers which was being installed in another compartment, and by taking a place among those working on it was able to learn the details of its construction. That construction was simple enough, I found, amounting in fact to hardly more than a use of many smaller tubes within the main tube-propeller, smaller tubes which drew air from different directions upward and ahead, and thus by their shaping and construction were able to fling a great air-city supported by them onward through the air at that tremendous speed. I had learned the great secret for which hundreds of our agents had sought, and needed only to escape with that secret.

"I needed only to escape, to race back to my own land, and knew that it would take our own engineers but a very short time to fit our own cities with similar speed-tubes, since though the European and Asiatic forces had been working with them for months that work so far had been mostly experimentation. But it was then, when I tried to escape, that my luck came abruptly to an end. For I was captured by the fleet-officers here in Berlin as I was on the very point of leaving, captured when the false identity which I had established at such pains was upset at the last moment through the detection of one of the documents I had forged. I was captured, and knowing that I had within my brain that great secret of theirs which would make their air-cities resistless, they would never, I knew, release me. They took me at once before their commander, the First Air Chief of the European fleet, and then by him and by a number of the Asiatic Air Chiefs also I was questioned exhaustively.

"They wanted most to know what other American agents like myself were hidden within their air-cities. They knew that those agents or the greater part of them were known to me, and they knew that if I described or named them they would be able to catch them all and thus prevent the possibility of another spy learning their great secret as I had done. I refused utterly, though, to give them the information they wished, to reveal to them my fellow-agents in the various cities. At last they saw, after days of questioning and half-torture, that they could not as yet wring from me that information, so confined me here in a cell high in the central tower with the information that only death awaited me within days unless I acceded to their demands. And, confined here, I saw from the window that the whole European Federation fleet had begun to mass here at the air-city of Berlin, quietly and unobtrusively, and guessed then that they meant to loose their attack upon the American Federation.

"The great tubes that were to move their cities through the air at such terrific speed were not yet finished, but they did not wait for these, launching out their great fleet of cruisers which with the Asiatic fleet outnumbered the American ships by two to one and should be able to overwhelm them, they thought. I think that their reason for starting that attack so soon, before their greater preparations were completely finished, was that they feared lest another spy like myself might discover their great secret and escape with it. So they let loose their fleets upon the American Federation to begin the war and forestall that contingency by beating down the American forces in a first tremendous attack. If that first great attack failed, they could swiftly complete the preparations that would make their air-cities of such immense speed and power, and then could launch all those air-cities upon the American ones in a second attack that nothing could resist.

"And even now, despite that daring and deadly attack which your ships made here upon Berlin tonight, and upon Peking, as you say, the great preparations of the European and Asiatic Federations are going swiftly on, and soon now those preparations will be completed and their great air-cities will be able to whirl through the

air at that tremendous speed. And then will come the end, for our American Federation. The two hundred air-cities of the European and Asiatic Federations will flash upon our own nation from east and west, with all their millions of people and giant batteries of heat-guns, and will send our own slow-moving air-cities crashing to earth, will send all the scores of cities and all the millions of people of the American Federation into destruction and death!"

"Destruction and death!" Connell's voice seemed echoing still about us there in the silence when he had ceased, seemed beating like great drum-notes of doom in our ears. Macklin—Hilliard—they sat beside me in the dark cell as silent as myself. And in that moment we heard again, from outside and far beneath, the great throbbing roar of the life of all the mighty air-city about us, the humming rush of cruisers to and fro above it and the dull mingled voices of its great crowds, coming dimly up to our silent little cell high in the mighty electrostatic tower. Then suddenly I had risen to my feet.

"Destruction and death—but there must be some way in which we can prevent it!" I cried.

"What way is there?" Connell's tone was low, hopeless. "We only know what looms above our nation, know that these preparations are coming to their end, that these air-cities plan to rush upon our own. We cannot halt the preparations that are going on in every air-city of the two great enemy Federations."

"But if we could warn our own!" I said. "If we could get what you have learned back to the American Federation—could install in all our own air-cities similar new tube-propellers—then our cities could at least meet the attack of the enemy cities with equal speed and power."

"But how to get back?" asked Connell. "How to escape from here? It could be done, if we could escape, for the new tube-propellers could be put in our own air-cities swiftly enough, yet to escape is impossible. I have been here days, weeks, Brant, with the one thought of escape uppermost, but the thing is hopeless."

(To be Continued)

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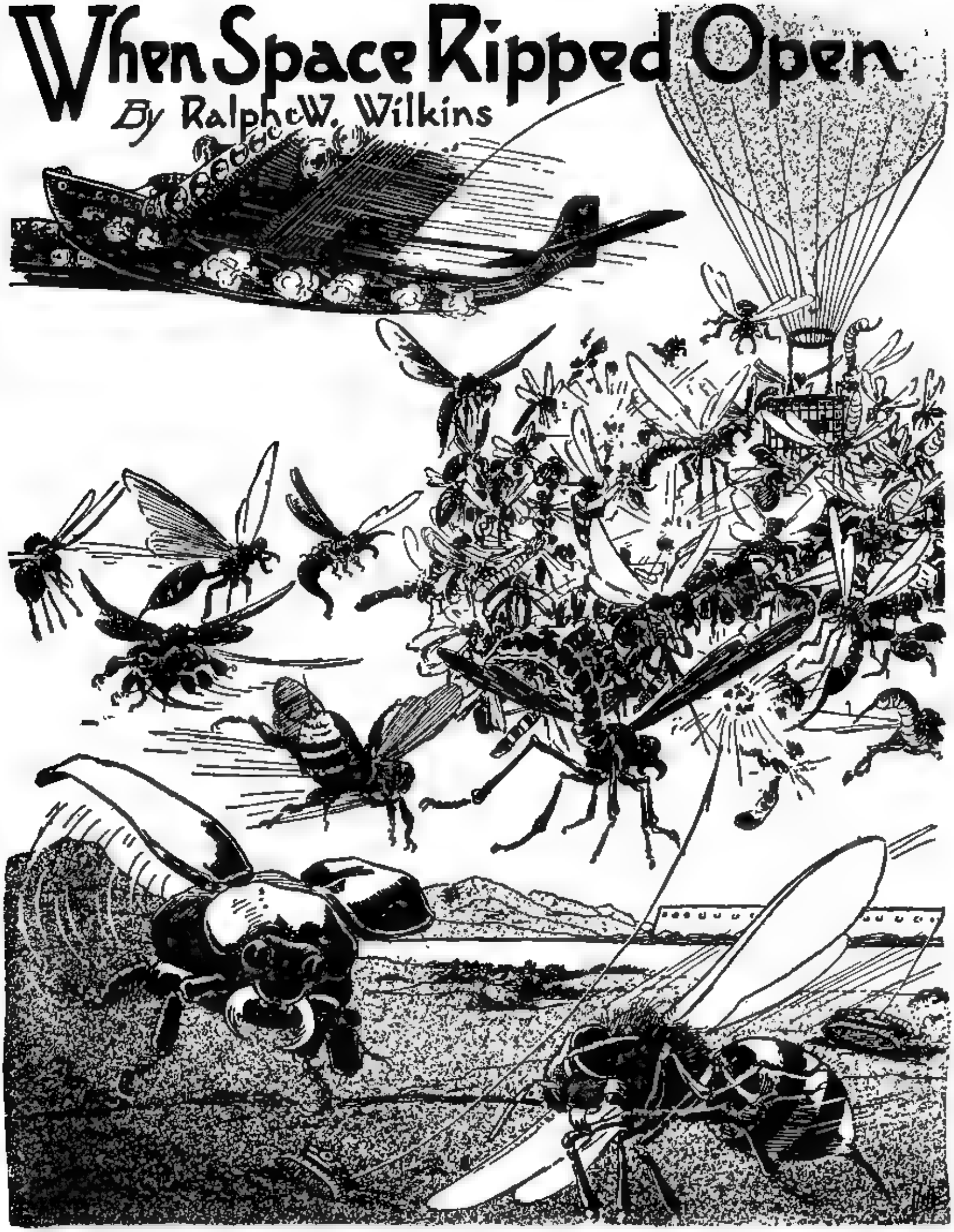
When Space Ripped Open

By Ralph W. Wilkins



At the first volley the shells took effect and a great gap was blown in the mass of flying monsters. They swarmed about looking for their enemy Round and round them we circled, all our guns trained to port, firing broadside after broadside.

WHEN SPACE RIPPED OPEN

WE WERE all seated cozily in my stateroom on the *Meteor* while a heavy storm raged outside. In spite of the nasty weather, the great airship winged her way through the air above the old continent of Europe with a scarcely perceptible motion. We had been drawn away from the promenade deck—not because of the storm, for the deck was, of course, enclosed. But a blaring, feverish dance was in full swing on that part of the ship and we, anxious to escape crowds and the rush of city life, gave the place a wide berth.

It seemed, in fact, as if the thousand-odd passengers on the *Meteor* were engaged in a conspiracy to rob us of the peace and quiet that we had hoped to find aboard the great airboat. A talking picture was being screened in the drawing room; an impromptu male chorus was roaring out a repertoire of choice songs in the smoking room; and the lounge was filled with flitting, gabbling creatures who were constantly coming and going from the ball in progress above.

RALPH W. WILKINS

We were driven perforce into a stateroom, and mine happened to be the nearest. /There we sat in glum silence for a while, sipping the drinks that the steward had brought us. Finally the Philosopher spoke.

"After all," he said, "where is there to be found a better place to spend a blustering night like this? Here we are, snug, warm, and cozy while, far below on land and sea, winds blow, rains lash, and cold bites. It is just the sort of night for the Captain to say, 'Antonio, tell us a story.' That is all we need to make this a night of nights—a good story. And although it is not his turn to do so, I more than half suspect that the Historian has in his possession a yarn worth hearing."

The Historian smiled: "I don't know where the Philosopher learns all he knows," he said, "but it is true that I have recently unearthed a very strange and vivid yarn (as our friend here calls it) concerning the 'Great Catastrophe' which fell upon the race near the end of the twentieth century. It is very startling to recall, is it not, that at that time—only three hundred short years ago — the wild waste which we knew as Europe was a very populous country? Asia, too, was peopled by millions of human beings, and so also were South America and Africa. We accept too readily and with too little reflection the fact that man managed to meet and overcome the great problems of that awful time. We don't like to remember that man was very nearly swept from the face of this globe. The wilderness below that covers what were once France, Germany, England and Russia, stands as a mark of our struggle for survival. And the windy wastes which were once China and India bear also their silent testimony.

"If we give the matter a thought at all, we count it a matter of great good luck that mankind kept a foothold on the continent of North America where our great civilization now flourishes. As a matter of fact, it did not seem to have been within the plan at all (if there was a plan) that man should survive. All the forces of nature seemed working together to exterminate him. That he survived at all was due to the genius of a truly great man, Professor Abelton. That he was able to keep the flame of knowledge and culture from being extinguished during those fateful years was due to a single fortuitous fact. Without that single advantage, even the genius of Professor Abelton would have been impotent.

"Recently, in my researches, I came across a document written by one who passed through the events of that awful time. The man was observant, intelligent, and evidently well-trained in the science of his time; he illustrates in his writing the splendid spirit which actuated the group of which he was a part. Upon him and men like him rested the fate of the world.

"Naturally, the great events through which he lived left their impress upon him. Toward the end of his life, he set these impressions upon paper, and it was my good fortune to find them. He seemed to realize—as I think you will feel, if you hear his story—that the fate of mankind depended on how he and his comrades played their parts in those awful stirring times. Would you like to hear his story?"

When we had heartily assented, the Historian took from his pocket a frayed and yellowed manuscript. He settled himself in his chair, took a long drink from his erstwhile-neglected beverage and began reading this strange and wonderful tale: And as we listened, we lost our awareness of our surroundings, of the peace and comfort of this age. The Historian transported us to a stormier time.

WE never become too tired to shout from the house tops warnings of the insect peril which faces humanity and now is, we believe, greater than at any previous time during the history of this planet.. When wild animals roamed the earth, it was a comparatively simple matter to exterminate them, because they could be fought in the open and held in check. But against insects, humanity is at a terrific disadvantage; because by the time certain insects and their ravages become known to us it is usually too late.. Witness, for instance, the recent collapse of over twenty banks in Florida caused directly by the ravages of the Mediterranean fruit fly; which so damaged Florida crops that an enormous number of the fruit growers of Florida were ruined.

Modern transportation is one of the reasons for the increasing insect peril. Years ago, it was comparatively difficult for insects to emigrate from one country to another.. Nowadays, our trans-Atlantic steamers, our railroads, and our airplanes are frequently infested with certain insect types, and they are usually discovered too late.

"When Space Ripped Open" deals with an insect peril of a totally different type; yet the fundamentals remain the same. Incidentally, you will find this a tremendous story from beginning to end.

CHAPTER II

THE MANUSCRIPT

The Coming of the Terror

WHEN the star that had so long flared had passed, and swung its green, baleful mass into the cold, far, reaches of outer space, men smiled again—but not for long. Those who had foretold a fiery collision with the earth were proved wrong—but not entirely. For, at the very moment when mathematicians had predicted that the crash would come, the earth did indeed seem to falter in its steady course. A convulsive shudder seemed to run through the vitals of the world and many seemed to hear at that moment a sound like the twanging of gigantic bow strings. Then they knew no more. For although no deaths occurred, the whole world at that moment was plunged into unconsciousness. A strange gas, coming apparently from nowhere, swathed the earth in a mantle of involuntary sleep.

When the world awoke again, it found great conflagrations sweeping through its cities, trains piled upon one another in horrible confusion, and great ships sinking and burning at sea. Had this been all, horrible though it was, mankind would have closed up its ranks and recuperated its losses. But this was not all!

The world seemed suddenly to have gone mad. News editors at first refused to print or to believe the extraordinary incredible evidence of their eyes as the paragraphs came ticking in to their offices. "Great monsters preying upon the world," they read. "Coming apparently from nowhere," they saw further along on the message: "Giant insects a hundred feet in length sweeping across the sky."

Frantically they 'phoned each other, all over the United States, and found to their horror that the dispatches of the other papers but corroborated their own. Somehow, in a manner nobody understood, great rapacious monsters had appeared upon the earth and in the skies. It was unbelievable—but it was so! Great wasps far larger than any flying dragon of prehistoric times were roaring through the air, said the dispatches, coming from many diverse parts of the world.

The papers printed their impossible tales at last, and were filled with pictures, sent by radio, of the monsters that were invading the world. No one in North America knew what to believe. Many considered it to be a gigantic hoax; for how could it be possible that these monsters should appear thus suddenly from nowhere? And further, if they had indeed come, why were they not to be seen in North America? Anxious eyes peered fearfully at the sky, however, to assure their owners all was well. And the skies remained as calm, serene and familiar as ever before.

The newspapers began sending airplanes to the places where the monsters had been seen. Of the hundreds sent, not one returned to report. Then another sinister thing occurred: one by one, the news stations in Europe, Asia, Africa, and South America became silent, like lights in the darkness blinking out, one by one!

Try as they might, the authorities could get no sane story of what was happening to the world. Such information as did indeed come in was like the wild imaginings of mad men—the hallucinations of delirium—or the wild frightfulness of a nightmare.

Soon no information came at all. America was cut off from the rest of the world. No ships from abroad entered our ports, no mail from foreign shores went through our post offices, and the wires and the air formerly busy with news of the world were ominously cold and silent.

In the midst of this wild confusion, there was one man who moved and directed others with a definite purpose, while the rest of the world either fought death with the frantic-impotence of despair, or—as in North America—moved about in fearful uncertainty. This man was Professor Abelton. It was natural that he, through his great corps of workers scattered throughout the world, should be the first to know the true stage of affairs.

Of the two thousand men and women who, at the time of the "Great Catastrophe," were working for the professor in various parts of the world, only five returned. These five came in high-powered airplanes from as many parts of the globe—but each one was agog and breathless with the same weird story.

Professor Abelton, you should know, was at this time widely known throughout the world; but had the great crisis of which I am writing not come, he might never have become the universal leader of mankind.

In the country then known as the United States of America, where the professor resided, he employed a force of over a thousand scientific workers; enabled to do so by the great wealth accruing to him from his many inventions. These men and women employed by the professor represented the flower of American science; for the fabulous wealth of Professor Abelton enabled him to pay salaries which attracted the very best. It was his dream to give science in this manner an impetus which would cause it to leap ahead as never before in the history of the world. The "Great Catastrophe" prevented his doing that; but it was this group of men and women who, working under his guidance, saved mankind from utter extinction.

Space Ripped Open

ON a vast tract of land owned by Professor Abelton, he had built a model town to accommodate his corps of men and women. This town and the offices and laboratories were situated upon a wide, high plateau in the western part of America, far away from any cities. Here a busy, happy community worked and played until the day when the five airplanes arrived from afar, bearing the news that the end of the world was near.

The professor called us together in the amphitheatre which was used for our convocations. When we were seated he walked quietly upon the rostrum and began speaking, his voice being reproduced by loud speakers at every point of the vast auditorium.

"Men and women," he said, "we are met here in a solemn and awful moment. It is our misfortune, as it is our privilege, to be living in a time when man is to be weighed in the balances of nature to see if he shall longer encumber the earth. I am speaking, as you are well aware, of the strange things that are happening in all parts of the world today.

"Every one is passing through a hell of doubt and uncertainty as to what has happened, and what is going to happen. The facts are these: some buckling in space prevented the wandering star from colliding with us; but the stress and strain on the superstructure of our universe was so great that in some way fissures have occurred in space, as we know it. The wrenching and pulling of the passing star as it swung back into the infinite has opened up some limbo in four-

dimensional space. Great apertures have been ripped open, and through them is pouring a horde—a mighty torrent of gigantic insects."

He paused and looked at us. "Am I making myself plain?" he asked: "You know that it has long been known that the possible number of dimensions, like the possible number of anything else that can be numbered, is unlimited. For most practical purposes the particular universe in which we are situated may be regarded as having its being in a space of three rectilinear dimensions, and as undergoing translation; which translation is in fact, duration through a fourth dimension—time. By great and sustained analysis, we are able to realize that this universe in which we live, is slightly *bent* or *contorted* as it were, into a number of other *long unsuspected dimensions*. It extends beyond the three chief spatial dimensions into these others, just as a thin sheet of paper—which is practically two-dimensional—extends not only by virtue of its thickness, but also of its crinkles and curvatures, into a *third dimension*. Do you see?

"Now, just as it is possible for any number of sheets of paper to lie in a pile in *three-dimensional space*, so it is possible for any number of three-dimensional universes to lie side by side in *four-dimensional space*, and to undergo a rough parallel in time. It is evident that our universe, by reason of its crinkles and curvatures, extends into the fourth dimension, and close beside us, 'nearer to us than breathing' swings another universe, inhabited by giant insects. It is too weird to be true; yet true it is. At this moment the gateways have been opened between two worlds! Some great cataclysm has occurred to rip space wide open! Evidently, for some reason we do not understand, the shock of the charging star which we so much feared was felt by this other world, and these horrible denizens, finding a way to escape open, are pouring into this world of ours!

"In South America, in Africa, in Europe and in Asia these great rips have occurred and through them the fantastic creatures of the other world are madly tumbling to safety. The world from which they are coming is apparently much larger than this one; for the number of giant insects entering our world seems infinite. In some places the sun has been darkened by the myriads of winged horrors in the sky, and the earth is literally covered with monsters whose habitat is the land.

"At present, they are mad with fear. Presently, when they find themselves safe, they will begin to hunt. Man, in adapting the earth for his own use, has nearly cleared it of all animals which these monsters might eat. In consequence, these creatures will hunt man!

"Armies of ants have been observed, and each ant in those armies is ten feet long. Wasps weighing five hundred pounds at least have been seen by the hundreds, roaring across the sky. Dragonflies which are not flies, but real dragons, have already swept down and made gruesome meals of helpless human beings.

"It may be thought by some that Nature is preparing to give over the earth to this new form of life; that this terrible thing that has come upon us is part of nature's plan. Be that as it may, I can not sit by and supinely submit. I think I can see the turn events will take. If I read the signs aright, we must do two things: first, we must build a town into which no hunting insect can come. Then, when we have caught our breath, we must build an airship big enough to sweep our enemies from the sky. Nothing that we now have will do, for many of the terrors that have entered our world are larger than our largest planes. But, even in these, we can fly higher and more swiftly than our new enemies of the air; and the others which we shall build will enable us to return and fight another day.

"Perhaps there are those among you who listen to my voice who would urge that we bow to Nature in this matter—that having seen Nature's plan, we should put the lives she has given us into her hands to do with as she will. But I say to you, no! I am not one of those who fondly see in Nature a doting mother, watching over her children. I see in her, rather, a vain, self-willed old beldame, having her own way regardless of what harm or good comes to others. If you insist upon a metaphor for Nature take this. Nature is our cruel fruitful mother. We are her children—born out of wedlock, and hated by her who bore us. Now in her wantonness she had conceived again—and would drive us out to make home for her latest spawn. Submit? Never! We, the old beldame's first born, are coming of age. If we could but rid ourselves of the curse of hate that she bequeathed us, all would be well. She will oust us, will she? Not by a damned sight! I call upon you, my friends, to aid me in resisting this outrage, this insult—and to show the old wanton that though she gave us life, we will live it as we chose, and abdicate it never!

"Men and women, this is a turning point in the history of man. If there be a God, he is on our side in this fight! Men and women, what is your answer to me?"

Our answer was an exultant shout that rose from a thousand throats and mounted and rang in the round blue vault of heaven. The fight was on!

CHAPTER III

The Last Refuge

HAD some Rip Van Winkle slept but ten years at this time, he would have been a thousand times more amazed at the changes in the world about him, at the end of his nap than his ancient predecessor. For, in the short space of ten years, the face of the world was changed. Nearly ninety per cent of the population of the globe had been swept away to death in that short space of time. For, in the first onset, those who came in contact with the hordes of gigantic insects were afflicted with a mysterious malady which brought death in a few hours. This plague killed millions; and other plagues, resulting from the unburied dead, killed millions more. Of those who remained, hundreds of thousands met a horrible fate in the dripping maws of the great terrors who now infested the world. Had it not been for Professor Abelton and the great corps of men and women who worked with him, the world would rapidly have plunged into a darkness more gross and deep than that which covered Europe at the fall of the Roman Empire.

The wilderness once more conquered the world; and now the wilderness and the sky above it were filled with monsters more fierce and more terrible than even those of Mesozoic times. The dominion of man was confined to one strange walled and roofed city in which we lived and Professor Abelton ruled. In all other places those men who had survived became furtive, hunted creatures, cowering in caves or in the deserted skyscrapers of their once-proud cities.

In the first few months of the invasion of the great monster insects, the rural reaches of the world were

cleaned of their last shrieking human food. The great hordes of insects driven by ravenous hunger, picked the countryside bare. Men fled to the cities in countless thousands, so that the roads in every direction were crowded with pitiful fleeting figures. Into this maggot-heap of human life plunged the rapacious dragons which now ruled the air. The roarings and boomings of the monsters drowned the cries of the dying. Following these throngs, the monsters of both the land and the air found the cities. And then the cities ceased to be the abiding place of man and became the abiding place of Death and nameless horror.

Heroic attemps to stand against these creatures were made; but the ordinary weapons of the fighters made no impression upon the monsters. Their massive, tough armor of chitin, shed rifle and machine-gun bullets like drops of water; and, even when a missile did by chance penetrate a crevice in the armor or puncture a wing, the great size of the insects made the wound negligible.

Only heavy artillery and high-explosive shells were of avail against them, and these, did indeed work great havoc among the creeping creatures; but the flying insects learned to keep to the air when the guns began firing. Anti-aircraft guns were of little avail; for the world was unprepared for any such attack from the air, and the comparatively few anti-aircraft guns were impotent against the swarms of giant beetles, dragon-flies, great wasps, flying ants and other winged horrors which now darkened the sun.

The situation was made more hopeless by the millions of deaths caused by the plagues. A regiment of a thousand men would be decimated before a shot had been fired. Soldiers would drop dead in the very act of aiming a great gun. All transportation had ceased, and, when a community ran short of ammunition, the fighting ceased and the hiding and fleeing began.

The continent of North America was the only great land-mass on which the insects had not made their immediate appearance. But the four-dimensional world from which they had come was evidently so large that it was only a question of time before they began entering Mexico by way of the isthmus, and then the United States and Canada, in their constant search for food.

Every moment of every hour the giant invaders were moving over the plains and through the skies of South America, leaving behind them a waste and a shambles. But every minute of this precious respite was used to the best advantage by the Professor. His vision, foresight, energy and resource was like a cloud by day and a pillar of fire by night. At a moment when all earthly governments were breaking down, he enlisted the resources of the United States government in his cause; since without it, even with his own great wealth and scientific ability, he would have been helpless.

On the plateau where the professor's great research plant stood, a strange and wonderful town began to rise. A concrete wall, two hundred and fifty feet high and ten miles square, arose at an unbelievable speed. A mould or frame of metal and wood was set up, and the fluid concrete poured in and left to harden. Within the enclosure there were vast storehouses erected, and filled with an amazing variety of things from seeds to huge explosive shells. Large-calibre guns were mounted upon the walls by officers of the United States army, who were among the thousands who begged to be allowed to become members of the new community. Areas were laid out for cultivation; and small but efficient shops were built for the manufacture of such things as the foresight of the Professor told him that we should need. The trim, ship-shape factory in which the professor planned to build airplanes was a delight to my heart.

Stretching from wall to wall, and supported by strong metal posts, was a roof of great steel bars; and, when we saw the great hunting wasps drop from the sky upon their prey, we thanked whatever gods may be for the genius of our leader who could foresee such things and provide against them. For this grating could be electrified, and then woe to the flying dragon who alighted there! About the wall too, at a distance of one hundred feet, we erected a fence of these iron bars. This, like the gridiron roof, was connected with our great dynamos and, in the days that followed, thousands of monsters met their deaths there.

The First Encounter

THIS incredible feat was the only purposeful activity going on upon the face of the world at that time. Even in America, our leader was the only soul with the faith, energy, and resources necessary to carry out such a project. Truly, in all the world, and throughout all time, there was never a stranger city than that which we built at the command of the Professor, and called "Endurance".

Thousands, hearing that this ark of safety was being erected, asked that they, too, might be allowed to join the ranks of those who were doing the work. Thousands called, but few were chosen. The professor sadly, but firmly, sent away all those who could not demonstrate their fitness to join our ranks. Each applicant must show great training and ability in some branch of man's knowledge in order to be admitted; and so it was that there came into our community experts in nearly every field of man's far-flung empire of science. Artisans, as well, were chosen, and truly, there was never a better-manned town than ours.

Once we were interrupted by an attack of fear-crazed men who thought to take from us by force the town which they themselves had been too lazy or short-sighted to build. The ranks of the attackers were filled with those who had been refused admittance, and led by thugs and desperadoes who were far better dead. The attack came; but it had been foreseen, and a rain of machine-gun bullets and shrapnel took the heart from the cowardly rabble, and taught all others that the men of Endurance could give and take hard knocks, and that the city to which we had pledged our lives, we would defend with the last drop of our blood.

All earthly governments were breaking down, being unable to cope with the situation. In the areas where the insects had already come, the only government that man now possessed were new despotisms. For on the sites of once great cities, at the tops of mountains or great crags, on islands and some other easily defensible spots, there sprang up communities of furtive hunted men who lived under the rule of one or more strong self-willed individuals. This happened in America as well when the insects began to arrive. But, not having had the foresight to prepare for the contingency as had our leader, they faced two terrible futures. Either they would be wiped out by starvation, privations, and the raids of the hunting monsters, or being slightly more fortunate, they might survive in a state of semi-barbarism.

The horde of giant insects swept as harmlessly about our citadel, as the waves of the flood about the ark of Noah. All over the countryside, death and horror

reigned; but within our ark of safety, there was life and security.

I well remember the day on which we saw the first of the monsters. Airplane scouts who had volunteered for the service ranged far and wide seeking the first signs of the enemy. Day after day their radioed assurances of safety reached us—and then, early one morning, the watchers on duty at the radio were startled by the announcement that a flock of flying monsters had been sighted. "Stand by to receive us," the message ended.

The news spread like flame through ripe hay-fields, within our walled city, and thousands of eager eyes watched the far horizons. Suddenly, one—two—three—planes came speeding over the low hills which rose where sky and earth met. On, on, they winged their way, and soon were circling down to a safe landing. A section of our barred roof had been arranged to open and close automatically. From the opening thus made, an inclined plane ran down to the ground within. The planes having landed safely on our roof, taxied over to the aperture and slid slowly down the long incline to safety.

They had hardly accomplished this, when the radio began shrieking the distress call, and we discerned our two remaining planes on the far horizon, pursued by what appeared at first to be great dirigibles. Nearer and nearer they approached, and we discerned that the pursuers were a kind of gigantic beetle, horrible to behold, and well over a hundred and fifty feet long (as we later discovered.) There were five of them, and the terrific roaring of their wings filled the heavens with their noise.

Our planes could not help each other, for they were outnumbered more than two to one. They were spitting lead from their machine guns at a terrific rate—but were learning that such missiles had little effect upon these monsters. The nearer plane shook off its pursuer for a moment and in that respite the pilot coolly brought his machine down upon our roof; but before our men could open the aperture again the air monster had dropped upon his prey and begun tearing him with its great jaws and claws. The spectacle was horrifying! But, since we saw that our friend was assuredly dead, the professor gave word for the great electric current to be turned on. The moment the great switch closed, the dragon on our roof began to writhe and roll. The relentless current did its work well and, for the first time we had killed one of our enemies.

The second plane was not more fortunate. Three of the monsters hemmed it about, and one hovered above it. They followed its twistings and turnings with the tenacity of death and, suddenly, two of them closed in upon it. Down, down they swung in dizzying spirals. Then the three hurtling bodies seemed to poise themselves in the air for a moment, while a hot scroll of flame wrapped its blazing folds about them. Three blazing forms crashed to the ground while we watched spellbound, our hearts drenched with inward tears.

A series of sharp detonations indicated that the gunners on the walls had not lost sight of their new enemies; but at this strange sound the two surviving insects took themselves away. The first battle had ended.

But the struggle was not won; indeed, it had barely begun. From that day forward, each rising sun looked upon new monsters which had flown, crept, or crawled, into the surrounding country. All day long the sound of cannon reverberated from the walls; as the fighters on the watch for enemies warded off a new attack, or carried on a long deadly battle.

Gradually, however, the monsters learned that there was little to be gotten near our walls but hard knocks and sudden death—and the hordes passed on to less fortunate communities. But the country round about was filled with the creeping insects, and the skies were always black with those that ruled the air.

Punishment for Traitors

THE human mind is infinitely adaptable—and what had been a horror and a nightmare became merely a grim fact of existence. We came to accept these monsters as a part of our daily lives. A danger and a menace we knew them to be it is true, but within our walled and sheltered city, we felt ourselves to be safe. To see a thousand-pound, diabolical hunting wasp, or a score of them for that matter, go roaring across the sky, caused no more terror to us, after a time, than a veteran soldier feels concerning a flying shell which he knows to be passing well over and beyond him. I have seen as many as forty fifty-foot centipedes, digging about among the decaying bodies of the monsters which had fallen to the skill of our gunners or been electrocuted by the current in the great iron fence about our walls. This horrible sight attracted no attention, from the scores of men and women who were busy on the walls; yet, a few weeks earlier, the very sight of the monsters caused women to faint and men to lose the blood from their faces.

As the years passed, by dint of steady, willing work, and splendid leadership, our position was made secure. Only once had internal dissension threatened our security. Certain base fellows, feeling that the danger from without was over, sought to put themselves into power over us, by force of arms. For a time a fearful battle raged within our walls; but those who were on the side of right far outnumbered those who would have enslaved us to their greed, lust, and craving for power.

In the end, we conquered our traitorous enemies, and with these the professor dealt ruthlessly. He judged them, and sentenced them to a just death. One by one (there were nearly a thousand of them) they were forced to leave the safe enclosure whose shelter they had violated. They wept and wailed—but the professor was implacable. "I cannot jeopardize this last outpost of Man to your conspiracies," he said: "You sought to enslave your brothers at a time when all were working for the public good. How can you expect mercy? Mercy! I would sooner give mercy to one of those monsters who await you out there. They, at least, only follow their instincts; you have followed the dictates of your black, hard hearts!" And he signalled his men to go on with the eviction.

Dusk was coming on and, before darkness had long settled, cries and screams—such as I hope never to hear again—told us that the wretched beings who would not live with us as brothers had met a fitting end. The giant insects that roam at night had found them; and the end of those men was as terrible a thing as has yet happened in this world

After this, nothing within disturbed the even tenor of our ways. The life of man went on. There was marriage and giving in marriage; there was birth and there was death. We loved, quarreled, made friends and enemies as men have done since the world was young. But, because of the great fight which was claiming our best from each one of us, there grew up

among us a splendid spirit of co-operation. Men came easily to see in those hard days that, if the individual were to survive, he must work hard with others for the common good. Rivalry and dislike, there sometimes was; but, underlying all, was a steady current of good will and comradeship that was to make of the world, some day, a nobler and sweeter place.

CHAPTER III

The Expedition

SHORTLY after the events narrated above, our leader called his lieutenants together for a great council. "Our position here is secure," he said: "We have held this post inviolate for over ten years, and we are stronger than we were at the outset. We produce all that we need, and we are equipped to manufacture those things which our development demands. We have all manner of engineers and artisans in our ranks to man them.

"The material and munitions which the bounty of the United States government enabled us to store up is hardly beginning to show signs of being used; and, by the time it does begin to diminish, we shall have obtained more from sources which our gallant airmen have already marked for us.

"It is time that we thought of spreading the light of civilization which we have kept burning here. In any other age, the work we are doing here would be like a dim, flickering candle precariously burning in a desolate storm-swept waste. We should be utterly cut off from all other men. Already the roads have fallen into disrepair, and each succeeding year will see them worse. Railroads are, of course, just as bad, even for foot travel, and even if the engines are not already rusted beyond repair, the tracks will not bear them. In any other age, we could not travel a hundred miles without the greatest difficulty. But thanks to man's great friend, the airplane, we are not so situated. We can fly swiftly and far across the trackless sky to every point of the earth.

"I have said that the task that now lies before us is that of spreading to our surviving brethren in all parts of this continent, and then to all parts of this stricken world, the civilization that we have kept alight here. This will not be an easy task. All men and women who volunteer for this service will be taking their lives in their hands. You have seen, all of you, the fate that lies in wait for those who in these days go up into the air in ships. It will not always be so. I am now designing an airship which will, I hope, begin for us the great task of ridding the skies of our loathsome enemies. But the press and pressure of immediate duties hinders my progress, and that ship can not be built for some time. Should we not, therefore, while waiting for the completion of this great ship, bestir ourselves to succor those wretched survivors of the catastrophe who must, here and there about us, be living in utter barbarism?

"Those of you who go on this journey may never return; for the dragons of the sky are many and fierce, and we have nothing as yet to combat them. Therefore you must prove yourselves as wise as serpents, but you need not be, perforce, as harmless as doves. When flying, you may escape by rising to great altitudes; but eventually you must land—and that landing will be fraught with danger.

"Who volunteers," he cried: "Who volunteers for a service that will be remembered as long as man remains on this planet?"

We had all risen during the concluding sentences of our leader, and were standing in military formation before him, in two long lines. In those days, our life was one of continual battle; and we had adopted a military way of life by common, and practically unconscious assent. It was so natural and right in those rough days to fight, that one came to look upon himself as primarily a fighter.

The professor repeated his question. "Who volunteers? Let those who will step four paces to the left."

There was a ripple of lively movement in our ranks; but there was no little group of men standing off to the left when the ripple was over.

The Professor—a picture of amazement—asked incredulously, "What, not one?"

And in answer, our ranks cried in chorus, "No, not one, but all of us! We have all moved to the left!"

There was a far larger number of volunteers than could be used for the first expedition, because of both the limited number of planes, and the comparatively small area to be covered.

The Professor was not a man to bite off more than he could chew—and he had laid out an circular area a thousand miles in diameter as the scene of our first attempts to save those miserable survivors who were left struggling about us, sinking further every day into barbarism.

It was my good fortune to be among those who drew lots deciding that they were to be flyers in the expedition. Two voyagers were to fly in each plane—to relieve each other at the controls—to provide an observer during flight—and a machine gun operator and bomb thrower, if necessary.

Each of us received simple, concise instructions. We were to cover a triangular sector of the circle allotted to us; searching carefully for the habitations of men. We were also to keep an open eye for any stores that might prove valuable—such as tanks of gasoline, warehouses, arsenals, etc. We had large maps of the country round about and a definite sector marked the field of our operations. Crosses in red ink, and other symbols, marked the locations of arsenals, hardware, ammunition, arms, and other kinds of stores and warehouses which had once been in the locations indicated, and which might possibly still contain munitions which were of value.

We loaded many days' food supply for, although the journey on which we were starting was a short one for our plane, yet the way was fraught with danger and we knew not what awaited us before we returned. We mounted machine guns, packed rifles and bombs—for, although as yet we had found them of little avail against our great enemies, we yet hoped that by a lucky fluke, they might save lives. Furthermore, we were not sure of a friendly reception from those to whom we were travelling; and we meant to teach them, if necessary, that the men of our settlement were not to be trifled with. To this end also, we took gas bombs and, when our eyes alighted upon the first of those to whom we had been sent, were glad of our equipment; for they were a hard and sorry-looking lot.

I should like to describe all the voyages that were made by the intrepid souls who went on that first crusade into the wild places of the North American Continent. Women as well as men played their parts—for the challenging conditions of that time had broken down

the age-old superstitions of woman's unfitness for the high adventures of life.

Adventure With Nana

THE telling of all those tales would be but second-hand, however; and so I will tell you of the one I know, the one on which I was fortunate enough to go.

It so happened, and I suspect that the Professor had more than a little to do with it, that the charming and lovely Nana was assigned to the machine with me. It often happened that men and women who loved or were friends, worked together in those days. We—who had seen the manners and customs of a civilization crumble in less than a year—we, under the leadership of the Professor, had worked out a new and saner relationship between men and women. In our new way of life, woman was man's full equal—no longer bound and restricted by idiotic laws and customs.

To go upon this expedition was thrilling enough—but to be accompanied by Nana—that was heaven itself. As I contemplated the adventures before me and my beloved, I thought, perhaps absurdly, of Gareth with Lynette, and of all the other Arthurian heroes who had sought high adventure and good deeds, in company with the damsels of their hearts.

The day of our departure arrived. About the great level area beyond our western wall was stationed our fleet of tanks and armored cars—fifty in all—in which we went forth to hunt and kill the giant land-abiding monsters. They had been sent to their present positions to protect the aviators as they went to their planes.

We had used these tanks to such good advantage, that the country round about us was nearly freed of the curse of giant crawlers which burdened the rest of the world. But the insolent winged insects, those horrible dragons of the air, had as yet little to fear from us. They came and went as they would; and only our strong walls and steel-barred roof kept us safe from their lust for blood. Some indeed were brought down by shrapnel and anti-aircraft guns; but the success of this kind of attack was small and, in the end, of little avail against the myriads of wasps, beetles, dragon-flies, flying ants, and other winged horrors, whose very names we did not know.

Hasty good-byes were said within our safe enclosures, and then we hurried swiftly to our planes and, one by one, rose up and winged our separate ways to the destinations allotted us. No firing from the tanks or the wall batteries was necessary; perhaps the great noise occasioned by the assembled fleet of tanks made the insects cautious. At any rate, for some reason our flight from the city started auspiciously, without a disheartening attack from the monsters who ruled the sky.

As we rose heavenward, I gave one glance behind, and saw man's only citadel in the world, growing smaller and smaller. A wave of nostalgia swept over me, and a feeling of awe gripped me as I became acutely aware that security and peace lay behind—and that uncertainty and perhaps death lay before. Nana and I were sailing over a world that had been swept nearly clean of human life by pitiless forces; how could we, by any chance, stand to win?

Then I heard the steady beat and swing of my motor—and the throbbing voice of my machine seemed to say, "Win, of course we will! Beings who could make *me* are bound to win. And there shall be greater than I who will one day sweep the dragons of the sky before them in utter defeat! By my very aid now, you and the woman you have chosen are sailing over the earth at the rate of over three hundred miles an hour. In any other age, you would have been helpless. But men have given me life. And I, in turn, will give them life."

How I loved these planes, and particularly this, my own! It was as friendly and as knowing as a good dog, and a thousand times more helpful.

Although the danger of doing so was very great—it was best to fly as low as possible, lest we miss some village or squatting-place of mankind, or fail to see some important store of supplies. Giant moths, with a wing spread far greater than any plane of ours, fluttered below us and about us. In the fields below we saw great caterpillars, over one hundred feet long and ten feet wide, humping along over the uneven ground. We saw one of them attacked by a giant creature half as long, but armored, and equipped with horrible jaws. The caterpillar pulled and writhed, knocking down great trees in its struggles to get away. But its adversary hung grimly on, gripping and biting until the scene of the struggle was covered with green and yellow slimy matter as the life of the great caterpillar oozed out. Centipedes of gigantic size ran with incredible speed over the earth; and on that trip I saw one fully one hundred and fifty feet in length—an incredibly horrible monster! I wondered fleetingly what bloody battles had been fought between lions, tigers, elephants and other great mammals, and these monsters, in the tropic jungles. There could have been but one outcome to such struggles—for these horrors were armored and armed like battleships.

In some places the roads seemed good beneath us, but for the most part they had fallen badly into disrepair. Floods had washed them away, bridges were fallen down, and great trees, abandoned vehicles and other wreckage blocked the way. The railroads seemed to be in better shape, although we were not close enough to make a detailed inspection. Once we passed a long train of cars stopped at a wayside station, for all the world as if about to take on passengers. Out of curiosity, I circled about it—and rose quickly as the snout of a great hunting wasp was pushed through the door of the rear car.

Survivors

NEAR this spot we came upon a good-sized town; this we explored but found no men there. Something else, however we found. As we stood in the street, a hideous form came hurtling from a dark old ruinous house that faced the road. Whether it was a spider, a scorpion or a giant ant, we shall never know; for as it rushed toward us, both Nana and I hurled high explosive-bombs into its slavering jaws and ran as if pursued by worse than a thousand devils—as indeed we were. With shaking hands, I twisted the propeller and, with equally shaking hands, Nana worked the controls. In a moment two badly-scared mortals were sailing over the town which nearly had claimed them as permanent inhabitants. It was appalling to think of what would have occurred, had our bombs not blown our attacker to pieces.

We flew on in silence for a long while my nervous eye raked the heavens for another assailant. It was well that I did so, for with a roar that filled the heavens and drowned out our motor, a great hunting wasp came shooting across the sky. I seized another bomb, in the vain hope of making an effective throw before our new enemy should land. A second glance showed me that he was not heading for our plane. Nana pointed and I saw, unmistakably, a man running for

his life across the fields below. The great wasp dropped like a shot upon his prey—and I was violently sick as I saw him carrying the man away with him, like a fly writhing in his jaws.

Nana sent the plane climbing upward until we were higher than any of the monsters ever flew—and circled about until we had recovered our equanimity. Then she brought the plane down again in wide spirals. We both felt sure that the man we had seen was no isolated individual, living a solitary life away from his fellows. On the contrary we felt sure that we had at last reached a settlement of men.

As the plane glided to earth I felt, more keenly than ever before, how dangerous our mission was. The great insects lurked in wait at every turn, and we were only two weak human beings, far from help or assistance. By the time Nana had brought the plane safely to the land, there were fifty air monsters swooping down upon us. But all our planes were entirely enclosed in strong metal, and the danger of being seized was slight. The real danger had been averted when Nana had eluded the attack in the air. I let the machine gun rip away at them, but with no effect. Then, opening a port hole, I threw bombs, but these caused no deaths among the dragons who attacked us. Finally, however, the great detonations sent the monsters scurrying skyward, and in that respite we gripped our packs and weapons and hastened out of our plane.

We walked warily, in the center of the street, when we reached it (for this was the outskirts of a great city), our nerves a-tingle and alert for the slightest sound or sight that indicated danger. As we walked on, however, our confidence increased; for we met no enemies. Evidently the human prey of this place had been exhausted. We gazed with interest at the deserted houses, the lifeless shops, and the advertisements. On one hoarding there was advertised a moving picture entitled, "Metropolis, A Tale of Tomorrow;" and I wondered if the inhabitants, seeing the tale, had felt the slightest premonition of the amazing things, the horrible things in store for them "tomorrow". We walked like visitors from another planet—or archeologists of another age—through the streets of this town, through which we might well have motored in days gone by.

We saw a furtive figure slink behind an old red brick church—and a second later a wailing cry quavered upon the still afternoon air. A chill ran over me, making my flesh creep; but this was no time to be fearful of strange sights and sounds, and we continued on. We turned the corner, past the old church, down a long street filled with great houses. Bounding this street at one end was another, filled with great shops, and office buildings. A double car-track ran along this thoroughfare, and it was easy to see that in other days it had been a busy street. We followed it for a short way, and came upon a great wide park, at the end of which was situated a large yellow brick building, built in Gothic style. It looked for all the world like an old English castle—but its original purpose was made clear by the inscription over its doors, "State Armory".

CHAPTER IV

The Settlement

IN FRONT of this building was a group of the dirtiest ragamuffins I had ever seen. Old dirty garments were worn by some; others less fortunate seemed to be clad in sacking, and others still more unfortunate were nearly naked. Thin, hungry, furtive, and suspicious, they regarded us sullenly as we moved toward them. To this, then, men had fallen. A hunted, furtive beast!

I noticed that all the men were armed. Some carried swords, many had rifles; but I noticed that these all had fixed bayonets, and I concluded that the rifles were used as spears and clubs, there being no ammunition.

We walked resolutely across the park until we were within hailing distance of them. I am frank to confess that I gripped my repeating rifle tightly—and made ready to use it if it should prove necessary.

"Who are you—what do you want?" came the gruff question as we neared the group.

"We are friends," I cried: "We have come to bring you help."

"Where do you come from?"

"We are messengers from a settlement three hundred miles from here where there are fifty thousand people. We have food, clothes, and safety to offer you—and a way of living that is human and brave."

The big questioner, who seemed to be the leader, conferred with his men a moment, and then said simply "Come in."

He ushered us through the door way of the great armory, into the great drill hall within which now served as the assembling place of these poor wretches. There were settees and chairs, arranged in a semi-circular fashion, probably for such powwows as now took place. The men shambled into their places, the leader sat in a large arm-chair in front of them. These chairs were on a platform at one end of the hall; while we were directed to sit in chairs arranged below on the floor of the hall. Around the great place ran a large balcony, and we saw the heads of women peering over it—and heard the prattle of children, the poor little children whose lot it had been to be born here.

"You came three hundred miles, you say," began the leader: "That is a long way in these days—and the earth is full of terrible monsters. How is it that you were able to come? There are no good roads—no safe ways, and yet you look as fresh as if you had undergone no hardships in coming here. Do you wonder that we find it hard to believe you? If it were not for your fine weapons, and splendid clothing, we should call you liars or fools.

"How is it also, that in this day when all men's hands are red with blood of those they have robbed, you come with offers of help and food and safety? Can you wonder that we are not quick to answer you? We have seen terrible things done to man by the insects; but they are not so terrible as the things I have seen done by the cruel and ruthless bands who have from time to time attacked us. We have tried to live here with some decency, to keep what we could of civilization. But there are other bands who rape and kill and take from others by force the things they need to keep life within them."

Rapidly, I began to tell him the story of our settlement and, aided by Nana, I made them believe. They were a hard and bitter crew; but, as I painted for them pictures of our life at Endurance and contrasted it with the mean fear-ridden life of poverty that they and their children lived here, tears shone in the eyes of some of them.

They called in their women and discussed the matter.

"I will come with you," said the leader at length; "You have made us believe. I heard what was going

on over there at your city, just before the world broke down; but I had forgotten it until you told me again of the things that had been done."

"Come now then," I urged: "It is but a short hour away!" And I could not but laugh at the look of incredulous amazement on his face. "I told you that we had airplanes, did I not?" I said. "We came in one. How else could the journey have been made?"

This decided him. If we had an airplane, then indeed all our story was true; and we clinched the mattter by taking ten men with us and loading them down with the food supplies that we had taken with us. This concrete evidence of good will overwhelmed the poor hungry creatures and they sent us away with their blessings following us.

The leader gave instructions to his subordinates, and went with us back to the plane.

The sky was filled with the great monsters, and it was only after the most heart-freezing dangers and narrow escapes that we reached our plane in safety. We ducked, stooped, crawled and finally made the end of the journey in a burst of speed, safe and sound.

As the plane roared up into the high heavens, the new friend with us shouted to me, "I was an army officer in the old days. Airplanes are not new to me, but I never thought to see one again!"

The myriads of winged monsters who were awakened to flight by our rise into the air amazed me. I had been used to flocks of them; but the sky was literally black with them now. We climbed up and up in an erratic course and, finally reached the upper layers of the atmosphere where the cold and thin air made going difficult for our enemies.

Below, the air was filled with roaring, diving, winging baffled forms.

Civilization Spreads

NOW being safe, I set my course with all possible speed for Endurance. It was dusk when we arrived, and I thanked my stars that we had not been longer delayed—for we did not show beacons at night at Endurance, to avoid drawing the giant insects. As we came circling down, an horrible form came speeding out of nowhere—its jaws agape and its eyes aflame with insane rage. I opened wide my throttle and shot my plane upwards again. The hellish monster seemed to know just what was in my mind. He was not ten yards behind me, when something struck him. He swelled, and then exploded in a million fragments. One of the anti-aircraft guns on the walls had seen the monster, and had made a perfect hit. I landed safely.

Nana and I were the heroes of the hour, for ours was the first plane to bring back news of the other survivors of the catastrophe.

As a result of a long conference between the professor and the leader of the people we had found, ten planes went back the next morning loaded with the food, clothes, and other things these hapless bodies needed. This was the beginning of a constant going to and fro between the two groups. Out of the abundance of our storehouses, we sent load after load of material and supplies to our new friends; not in simple, silly free-heartedness, but in wise, good-fellowship. For each service we rendered, the recipient group pledged us a definite service of labor in return, and the pledges were faithfully kept. The men of our new town, long the hunted prey of the giant insects, took with joy and fervor to the task of hunting their former hunters. Their arduous labors in this direction, soon rid the country near them of the great terrors who had once held sway there. They worked like Trojans too, at the building of a walled and roofed town, smaller but similar to ours; and in a few short years were living a comfortable and civilized life such as we had founded and maintained.

Other groups were found and helped as the years passed; and in helping others, we aided ourselves. For from each town, in payment of our aid, we required a definite number of young men and women to aid us in producing the arms, planes, chemicals and tools necessary to our continued prosperity.

The busy years sped by hardly reckoned by us, so busy were we. And, imperceptibly, the country round about, for a radius of five hundred miles from Endurance, was dotted with smaller or larger towns, all built on the model that we had demonstrated to be successful. A quaint and beautiful state had sprung up, amazingly modern and scientific in some ways; amazingly mellow and picturesque in others. The nation of which Professor Abelton was the ruler was in no wise crude or inefficient. There were no idle hands in our community, and no privilege of position or wealth. One for all, and all for one, was the motto of Endurance and its daughter towns.

The catastrophe was in the end a splendid thing for man, I think. For in the great cataclysm, stifling customs and obsolete laws were cast aside—and a great leader of mankind organized a society upon the basis of scientific law.

The world, aside from the menace of the insects of the air, was a very beautiful place, at that time. Little towns throve in every hamlet. The songs of our happy, busy people filled the air and mingled with the songs of our airplanes as they winged their ways from town to town bearing peace and good will.

Our airplanes were as quaint and yet as efficient as the life we lived. They were as much a part of our lives—more a part of our lives—than dogs, horses, or any other animal had ever been to early man. Our planes were not built in great shops, and turned out by the thousand like so many wooden boxes; they were not built by men who saw them only as items in a profit-and-loss statement. Our planes were built by artists—by artists with a sense of flight. And we who built them knew that they were far more faithful and far more intelligent than any animal. Thought shone in them, and the loving skill of the artist was clear in every part. They were far more sensitive than the most highly-strung horse, and quick to detect roughness or gentleness in the hands of those who flew them. Their moods were legion, and they surprised, delighted—yes, and irritated—like any close friend. They could be coaxed, and they loved to obey one whose orders were firmly given. But they could be cruel and treacherous to the weak or lubberly, and to those who persistently maltreated them.

Yet were we not content. For these planes, beautiful and bright, and brave though they were, could not conquer the enemies of the *air*, as our tanks had done the monsters of the *land*.

Our tanks and tractor guns, slowly but surely had rid the *earth* of the brutal hulking terrors who cumbered it. Every day these tanks, looking themselves like great insects, lumbered out to their assigned areas, and patiently hunted for their prey. Having found the creatures, they blew them to pieces. Each evening the hunters returned with a record of their kills. It was dangerous, exciting work; but the going and going of

the tanks and their attendant guns was so familiar a spectacle that busy people, at the end of the day, often failed to notice their passing. This persistent hunting, however, had its effect and soon in the areas patrolled by our tanks there was little to fear from the monsters.

The Professor's Plan

THE greater number of insects, however, lived for the most part in the *air*. These, because of our inability to carry great guns in our planes, we were powerless to kill. As the reconquest of the land round about us became more complete, the number of our enemies in the air increased. This was because the land monsters had taken a deadly toll from the *larvae* of the air dragons—the larvae being left unprotected from the other devilish monsters who attacked them. Our tanks, indeed, destroyed these giant larvae when ever they could find them; but this was very rarely. The great flying insects made their homes in the great swamps which had come into existence and there they laid their eggs and there their larvae were hatched. Our tanks could not penetrate these great bogs, and now that their natural enemies were gone, the skies grew literally black with the winged legions who sailed through the air. It is impossible to describe the conditions of that time. For a time we had been able to cultivate fields beyond our enclosure. Now that was again impossible. Taking off and landing in our planes became a most dangerous operation, and scores of pilots were killed week after week.

Twenty years after the first invasion of monsters, we were again faced with a problem which tried the hearts and minds of men. And, as in the former time the Professor's great mind had solved the problem, so now he came to our aid with a weapon that vanquished the terrors of the air.

The announcement came about in this manner. The Professor called a great conference of all those who held administrative positions in our now far-flung confederation. When we were seated, he spoke:

"So far, we have done well. Our great confederation of cities holds undisputed sway over the countryside for miles about. But it is not consistent with the glory and dignity of man that he should cower in walled and roofed cities, or flee to the upper reaches of the air when his enemies pursue him. We must have some weapon in the air, which will do the work that the tanks have accomplished on the land. But it may not be a lumbering, slow-moving machine. It must be strong enough to carry heavy guns, but it must be also as swift as a bird in flight. 'Can it be done?' you ask. Gentlemen, it *must* be done. Our future and the future of mankind depends upon it!

"Long, long ago, I told you that our deliverance depended upon two things: the building of safe cities, and the building of great airplanes. The first of these steps, you have nobly completed. The second lies before us. During the last five years my mind has been constantly busy with this problem, and I am happy to be able to lay before you a plan for the craft that we need."

He spread a little pile of plans and blue prints upon the table. "The airplane itself," he said, "cannot become very much larger than the largest machines we now possess; because the support of much greater weights on the landing wheels is impossible. Not much more than six tons per wheel—the loads carried now—can be carried. If we built an airplane of the size we wish, the problems of supporting the weight, maneuvering on the ground, taking off and landing would be impossible of solution."

We looked at him enquiringly. If the airplane could not be made much larger, what then was in the professor's mind?

"These problems are, however, easy to solve," continued the professor, "in the hydroplane.

"A year ago we dammed up the river that runs through the valley and now we h a v e converted the gorge that surrounds this plateau into a great lake. I told you that the project was for defence, and so it was; but it is for defence on a greater scale that you ever dreamed. It does indeed furnish a barrier to any land monster that might come near us; but its real purpose is that of a landing place for the great hydroplane which we shall build to sweep the skies clear of our enemies. No matter how great we build our hydroplane, it will be easy to land it in the water. Here are the plans. Yours is the task of building it!"

* * *

Within six months, on the professor's birthday, we presented him with the *Conqueror*, the first of the fleet which was to win back for man the heritage he had so nearly lost to the terrible, giant insects.

I have said that we who made airplanes were actuated by a love for the beings that we created. Need I say, then, that this new giant plane commanded the best that we had in us? Into it we put the best work of our lives. Five thousand of us worked upon the actual assembly of the great plane.

Ah, what a ship she was! Each part of her was a part of the soul of the man who had worked it. She was a poem of shining metal, the flowering genius of a people who knew and loved aircraft as no other people had.

The entire machine was made of metal—even the wing covering. The huge conical hull was entirely enclosed in metal on the upper and lower decks. The middle deck, however, was wide open—for here we mounted our great guns.

The Flight of the *Conqueror*

THE ship was nine hundred feet long, which gave us plenty of room for a battery of eight eight-inch guns, and twenty five-inch guns. The eight-inch guns were mounted in turrets, so that they could be trained in any direction; and the five-inch guns were placed at interval along each side of the deck.

To lift this terrific mass, we gave the *Conqueror* a wing spread of nine hundred feet. These wings, each four hundred and fifty feet long, swung from the hull at a sharp dihedral angle, and then curved down until they were horizontal.

We could never have flown her, however, had not the genius of the professor applied itself to the engineering problem. He had delved into the records made of gas engines; and he had seen that it was necessary to possess an engine more powerful and more efficient than any we now possessd in order to fly his great new machine.

No one will ever know how many sleepless nights our leader spent on his problem. But in the end he had perfected a rotary gas engine which we tested with tremendous success in our smaller planes.

The *Conqueror* was driven by twenty of these evaporative cooled-gas turbines which we placed in the

wings; ten on the starboard side and ten on the port side, to drive twenty propellers.

When we launched the *Conqueror,* a cry of great joy arose from the assembled thousands who had not until then seen the great ship. She slid down the ways—and into the great lake which now washed about the eminence on which our city stood. The finishing touches were made, ammunition and supplies were taken aboard, and I—to my great surprise and delight—was given command of her.

We were anxious to try our machine against the enemies of our race, and preparations were made to insure a successful battle. Although we could but ill afford the sacrifice, a hundred cows, pigs and sheep were taken from our flocks, and each was put in a steel cage. These cages were attached to captive balloons, the ropes of which were wound about winches, each of which was attached to a tank.

On the morning set for the battle, our tanks crawled out across the causeway which led from our city across the lake to the further shore. This was a distance of two miles; but the tanks crawled yet another three miles before they unwound their winches and let their captive balloons and their captive decoys rise into the air. It was fortunate for the occupants of the tanks that the winches operated from within, for the great dragons, scanting meat from afar, were now filling the sky. Already some were tearing at the cages with their hideous claws and jaws; and one or two balloons had sunk to earth under the weight of monsters who had seized the cages.

Incredible as it must seem to a world in which such creatures are but exhibits in a museum, there were fully two or three thousand of these chimeras in the sky.

Then the *Conqueror* rose. I was within her, and so could not see her flight from below; but the professor was so impressed that he wrote down his experiences, and I quote his words here:

"Four of the propellers began to spin, and the great boat moved imperceptibly forward to the accompaniment of an increasing hum. Two by two, the other air screws began to revolve, and the *Conqueror,* having reached the center of the lake, swung about in the direction of the enemy. For a moment, her movement ceased, and she seemed to crouch as if for a mighty leap. The engines and the airscrews roared together in a gathering crescendo as if they knew what lay before them and were bellowing a challenge. Then the *Conqueror* leaped forward, plowing through the water and spurting fountains of snowy spray. With a sudden spring, like a living thing, the great metal mass cleared the water. She sniffed the wind and rose until she was lightly skimming the lake's blue surface. Then, giving the lake's bosom a farewell caress, she rocketed up into her element—the air! Straight toward her frightful foes she flew, her guns already spurting death!"

At the first volley, the shells took effect, and a great gap was blown in the mass of flying monsters. They swarmed about looking for their enemy. Round and round them we circled—all our guns trained to port. Broadside after broadside we fired, until the sky was full of flame and the earth below was a shambles."

Within the plane, there was no cheering. To us, this was a dirty job to be quickly and thoroughly done. Gun crews, naked except for their trunks, loaded and fired with an efficiency that was more than human, learned through long hours of fighting on the walls and in the tanks. The ship, steady as a rock, made a perfect base for gun-fire.

The monsters, after a long battle, were reduced to a mere handful, and were seeking to flee. We gave chase, our great speed making this easy; ever and anon a battery would fire and one of our erstwhile terrors would fall to earth in shattered fragments.

We had demonstrated our superiority. No longer need we watch the sky with terror. A decisive battle had been won over the enemy, with the aid of the *Conqueror.*

The next day, flushed with victory, we flew to the nearest of the great swamps where the monsters had their refuge. There circling about, we saw wonders which we had not dreamed of before. Wasp nests a thousand feet long and half as high were built in groves of great trees. Holes we saw, ten feet in diameter, marking the dens of other wasps. Caves in the sides of hills marked the dwelling places of great beetles, and ant-hills that were actually hills rose among the gigantic trees.

Here we fought another battle, and hither for many days we returned, to rid the place of the horrors who abided there. Thousands of pounds of shot and shell were fired into the abiding place of death before it was purged of its hellish spawn.

We bombed and shelled the nests, hills, and caves, until no vestige of them was left, and when the rage-maddened survivors came roaring up to attack us, we served them a meal of dynamite and steel.

This swamp was the base from which the greater part of the insects in our locality conducted their operations, and the reducing it to impotence was a tremendous job. One day, however, we returned in the level rays of a setting sun to tell our people that the great swamp no longer hid a living monster. We had plowed it over and over with high-explosive shells. We had mowed down trees and swept away undergrowth, and finally set fire to the whole area. Few of the dragons who had lived there escaped, and those who did flew far away from the awful attack that had been launched upon them.

Man, with the aid of his new friend, the airplane, had once demonstrated his superiority over his brute foes, and had persuaded nature, indeed, to yield to him the inheritance of which she had tried to defraud him.

* * *

The Historian stopped reading, and we noted for the first time, so great had been our interest in the story—that the throbbing and pulsing of the dance orchestra had ceased.

No word had been spoken, so moved were we by the stark, simple grandeur of that tale. We could not speak. We stood in awe and wonder before the quiet courage and devotion to mankind that shone from every word of the simple story.

Silently we went out upon the deserted deck. Through the casement above, we saw the eastern stars hanging low, like great lamps in the purple sky. On the dim horizon, a yellow band was brightened in the east, and suddenly a bank of clouds flamed red as they caught the rays of the coming sun. Then, with terrifying speed, the sun leaped over the rim of the world, and spread beneath our feet a golden carpet, a magic mat from the mysterious East.

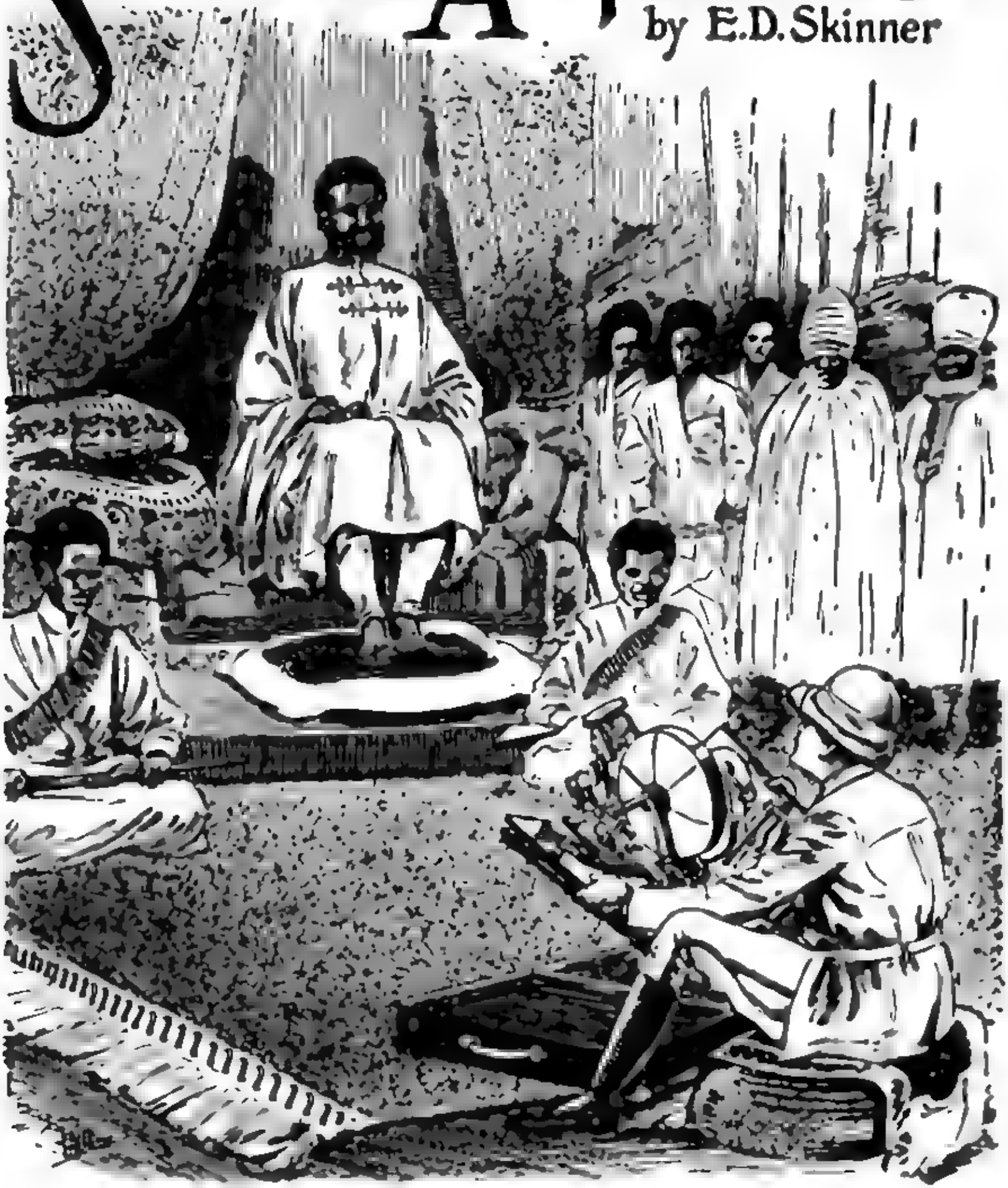
Nature smiled at us.

But I did not smile with her. The story I had just heard made me fear her. I shuddered, and turned away.

THE END

Suitcase Airplanes

by E.D. Skinner



Ten minutes later, he was explaining to Lidi Tawari Mabonnzo and a select few of his Rana, the diminutive, collapsible two-passenger biplane which he assured would prove their salvation.

SUITCASE AIRPLANES

MR Samuel Vandusenberry von Browne de Smythe, euphemistically known as plain "Sam Brown" to his more intimate associates, stumbled dazedly into his luxurious office and steadied himself for a moment with his hand upon his desk, while he stared around him with bleary eyes in a maudlin attempt to make sure that he was in the right place.

Quite evidently this was the "morning after." His silk hat was flattened down on the top of his head—a hopeless wreck. His full-dress suit was wrinkled and mussed and covered with mud—as were also his patent-leather shoes. His tie was flopping on a loose end, and his collar was unbuttoned with one side sticking straight out. He looked as if he had slept in the gutter.

After a momentary effort to gather himself together, he straightened up with a grim determination and stalked majestically across the room—with his feet wide apart to keep from falling. There he paused and gazed with a profound gravity at a huge "Astronomical" clock. The clock, he knew, was regulated each day exactly at noon by the direct action of solar rays upon a disk which was located upon the roof of the 157-story office building—the disk being connected with the clock by a fine copper wire. Also he knew that the daily variation of the clock had been averaging in the neighborhood of .0016 of a second. Therefore he reasoned that, for all practical purposes, the clock could be relied upon. In the course of time he arrived at the conclusion that, according to the clock, the time was exactly 10:32:14 A. M. of Wednesday, May 31, A. D. 2029. With a solemn importance, he addressed the clock as though delivering a judicial decision to a human. "You're dead right, Old Top," he said. "This's May 31 all right. Yesterday was Decoration Day. I know, for I got decorated! Hic!"

Then, finally, he became aware of a shuffling of feet on the floor behind him, which he knew from experience to be a deferential attempt to attract his attention. Wheeling about, he confronted a grinning negro boy, who deftly dodged his maudlin attempt to hit him.

"Boss want to see you right away, Mistah Samuel," the boy announced.

"Tell the boss to go to hell!" Sam exploded with another ineffectual attempt to hit the elusive negro.

"Get me 'nother job, an' I will," the boy grinned.

Then, suddenly, his face sobered.

"But honest, Mistah Samuel," he said, "Mistah Albert Edward Reginald Gordon-Cummings, the President o' this here United States Amalgamated Aviation Consolidated, him do want to see you mighty bad. He's been stewin' 'round like mad ever since nine o'clock, when you all should've been here. It must be somethin' mighty important. He said as how nobody but the chief of the sales department could handle it."

Sam "sobered" on the instant!

"Here you Imp of Satan!" he snapped addressing the negro. "You get my best business suit out and everything ready quick. Savvy?"

And then, as the negro obeyed orders with an intuitive alacrity, he himself marched back to his desk with the gleam of a definite purpose in his eye—though he still kept his feet wide apart to steady himself.

Once arrived at his desk, he flopped down into his swivel chair, snapped the bracelets of an "Electric Regenerator" upon his wrists, set its regulator at "2 Seconds," turned on the current, and relapsed into a momentary unconsciousness. Awaking at the expiration of this two-second equivalent for two nights of natural sleep, he appeared somewhat refreshed.

E. D. SKINNER

With a clear-headed precision, but with a groan of physical pain as he muttered: "My God! What a headache!" he wheeled around to a small silver urn bearing a gold-inlaid inscription describing it as a receptacle for "Pasteurized Water" — which made the thing conform outwardly to the 'steenth constitutional amendment which had been enacted at the behest of the powerful "Anti-Impure Water League," and which forbade the drinking by anybody of any water which had not been scientifically treated for the elimination of all impurities. With the aid of a diminutive microscope with a flexible glass lens, which he took from his vest pocket, he picked out an all-but-invisible needle-point in the filigree ornamentation of the faucet of this urn, pressed this point with his thumb-nail, extracted a coffee cup from a secret drawer, held it under the faucet, pushed the button which was intended to be visible, and, defying the law which had been passed long before the "Anti-Impure Water" prohibition was ever thought of, drew a cupful of steaming hot essence of real coffee.

YOU of course remember the first airplanes, the big cumbersome ungainly things of the early days that make you smile when you see them today. You remember how we had biplanes and even tri-planes and how slow they flew and how cumbersome they were.

The careful observers are saying that planes of all types will tend to become smaller and there are those that foresee the time when individual planes will not be larger than the small automobile and will weigh much less.

Consequently, the idea which our new author sets forth in this story, while of course humorous and supposedly a burlesque on all things scientific, is really not as far-fetched as it might seem. And while we may not have suitcase airplanes in the near future, you will find that this story is a welcome relief in its subtle humor, particularly in the way the author pokes fun at scientific things in general.

Sam Regenerates Himself

NEXT he pressed a spring on a highly ornamented fob attached to his watch chain, which caused it to fly open. This disclosed two compartments filled with small pills, with one lot much smaller than the other. Extracting one of the smaller pills, he dropped it into the cup of coffee. The pill itself actually was a recently discovered chemical compound called *Formine*, and it had been decided by the supreme court to

be a successful evasion of all the prohibition laws so far enacted. It was said, however, that the central committee controlling all the various "Anti" societies was trying to do something to justify their high salaries by devising a new law that would remedy this defect. Others claimed that this committee was letting these rumors out in the hopes of scaring a worth-while bribe out of the people it would affect. Be this as it may, this little pill when mixed with coffee actually did produce a powerful drug which was most distinctly forbidden, though it was a superlative corrective for the after-effects of intoxication.

Having hastily swallowed this cup of coffee, Sam promptly drew a second one, dropped another tiny pill into it which he took from a receptacle in the secret drawer and which was stamped "Essence of Sugar," followed this with another which was marked "Essence of Cream," stirred the mixture up with a spoon, extracted two of the larger pills, which were stamped "Equivalent—1 Meal," from his fob, deliberated for a moment as to how many meals he had missed and decided that this would sufficiently readjust the gastronomic deficiencies in his system, and, finally, hastily swallowed the two pills and washed this his double meal down with the one cup of coffee.

Then he sprang energetically to his feet, stripped himself of his clothing—which he scattered broadcast over the office for the dutiful negro boy to pick up—and walked quickly back to the rear of the room. Here he pressed a button in the side-wall which caused a panel to slide to one side. This revealed a marble-lined recess divided into two compartments, one of them apparently empty and the other containing what looked like an ancient suit of armor lined with Turkish towelling. Going into the empty compartment, he pushed one button and was promptly sprayed on all sides with hot water. Then he pushed another button, and was sprayed with a highly perfumed essence of soap which quickly lathered. Then he sprayed the soap off with the hot water again, and finished with a dash of cold. In conclusion, he stepped over into the other compartment and stepped into the suit of armor, snapped it shut about him by touching a spring, pushed a button and was given a brisk rub-down by the violent agitation that resulted in the framework of the device. At the last, he finished by hastily combing and brushing his hair by hand.

A moment later, arrayed in the neat business suit the negro boy had laid out for him, he stepped briskly over to another panel in the wall over which was a sign reading "President's Private Office," and pushed a button which caused that panel to slide to one side. This revealed a deep recess ending in a large tube. Upon the floor of this recess lay what looked like a huge cartridge shell, seven feet long. But this shell was divided into two sections longitudinally, and the top half was swung back on hinges revealing the interior. The interior was heavily cushioned to make a comfortable bed for one person, and, between the cushioning and the exterior shell, there was an elaborate system of shock-absorbers.

Without hesitating, Sam hastily threw himself into this shell, touched a spring which caused it to snap shut, listened to the rattling of the machinery which he knew automatically enclosed him in an air-tight extension of the pneumatic tube at the end of the recess, felt a violent jerk in spite of the shock-absorbers as the compressed air shot him through the tube—and, a fraction of a second later, stepped debonairly into the presence of his boss.

Mr. Albert Edward Reginald Gordon-Cummings, President of the United States Amalgamated Aviation Consolidated, glared at the intruder in a fury, glanced hastily at the huge "Astronomical" clock on the wall, and exploded.

A Case of Suicide

"NICE time to be showing up for work, young man!" he snorted "Do you know what time it is? It's exactly 10:47:18 A. M. of Wednesday, May 31, A. D. 2029, right now! And you are supposed to be here at precisely 9:00 A. M. every working day. This little splurge will cost you one-half day's pay to teach you a lesson this time. Next time I'll fire you. What have you been up to anyhow?"

"Thought you wanted to see me about something important," Sam parried with an injured air.

"Yes, damned important!" Mr. Gordon-Cummings raved back at him. "I've been hunting for you ever since six o'clock this morning. If you took any interest in this business at all, you'd at least be somewhere where you could be found at any time. I'm on the job twenty-four hours straight every day, Sundays and all. I never sleep when the welfare of this business needs me. If I looked at my job, timing it by the clock and then not showing up on time unless I happened to feel like it as you do, the whole thing would go to smash in no time."

"All of which get us a long ways towards solving the important problem you imagine the success of this business depends upon—I don't think!" Sam retorted testily. "If you've got anything of real importance on your mind, open up and let's have it! You can do your rag-chewing afterwards."

"I got a private message at exactly six o'clock this morning, which may or may not be correct as it came through a spy who is none too trustworthy," Mr. Gordon-Cummings answered impatiently with a somewhat crestfallen air. "Anyway, the information is that the Abyssinians have definitely determined to fight the English-French-Italian combine which has their country completely surrounded, and which has been strangling the life out of them by stopping all shipments of goods into and out of the country, excepting what they choose to let go through.

"Any war like that, under the present conditions, is nothing but plain suicide for them. But if we could get a supply of our new airplanes through to them, with sufficient light machine guns and ammunition and somebody to handle the planes for them, they might possibly pull the trick even at that. Give them the things to do with, and they're the un-Godliest fighters on earth. Of course they haven't got the money to pay for the stuff, and, the way things are now, they never could get it. But they've got mineral wealth in those mountains of theirs, which is something enormous. So far, they've persistently refused to let any foreign concessions to work these mineral deposits, preferring, with a heroism you can't help but admire, to fight it out in the face of impossible odds and try to save their own country for themselves.

"But they're actually face-to-face with certain extinction right now. You've got a glib tongue, and you might be able to persuade them to save themselves by granting us these concessions covering all minerals in their mountains, if we made it possible for them to

win. It's life or death for them, and the concessions would be worth a thousand times the cost to us."

With a bounce, Sam was over to a blank space on the wall.

Then he hesitated a moment, scratched his head, and turned to his boss.

"What's the air-line distance from New York City to Addis Abeba, the capital of Abyssinia?" he added with a puzzled frown on his face.

"How the hell do I know?" Mr. Gordon-Cummings answered testily. "I haven't looked in a geography since I was a kid."

With another bounce, Sam bounded over to a large globe suspended on a stand in one corner of the office. With nervous haste, he revolved the globe around until he found New York City. Into this he stuck a delicate needle he extracted from a receptacle in the framework which supported the globe. Then he again revolved the globe until he found Addis Abeba. Into this he stuck another needle. Then he slammed an exterior attachment down over the globe, and sent the globe itself spinning with his hand. A dial at the bottom recorded the distance as being "7061.29 miles."

Then he bounced back to the blank space on the wall, turned the pointer into the "7060" mile circuit, turned the pointer of another regulator to "14" degrees north of southeast, pulled a lever which connected a huge "Electro-Visional" apparatus, and a faint picture of Addis Abeba, the capital of Abyssinia, appeared in the left-hand corner of the blank space on the wall. Taking his flexible-glass microscope out of his pocket, he soon found the Gebi, or royal palace, of Lidj Tassari Makonnen the Negus Negusti, or king of kings, of Abyssinia. The "palace" actually was a smudge of low buildings slightly to the northwest of the center of the forest which all but hid the entire city. Sticking one of two needles attached to a fine copper wire into the gelatine surface of the wall at the point where the Gebi showed, he stuck the other needle into a point at the base marked "Local"—and the general picture of Addis Abeba faded, and a minutely exact reproduction of the royal palace itself replaced it.

"What's the big idea?" Mr. Gordon-Cummings snapped testily. "I could have done that myself. But what's the use? They're not in conference now."

"Got something under my hat!" Sam answered hastily. And then, with a malicious grin, he added: "I've been working on this thing a long time. Got it perfected two days ago. Couldn't find you anywhere—you must've been sleeping on the job or something—so I never got the chance to show it to you. Have Degiac Kassa here when I get back. I'm going to my office to get my new invention which will show you something. I'll be back in a second."

Sam Reconstructs the Past

A MOMENT later, he returned carrying a small metallic box in his hand. Standing awe-struck, with his eyes bulging out, there was Degiac Kassa the Abyssinian staring dazedly at the picture on the wall of the holy-of-holies of his native land.

With nervous haste Sam walked hurriedly over to the "Electro-Visional" apparatus, opened his box and set it on the floor and attached the interior works to the large apparatus with two fine copper wires, evidently designed for that purpose. Almost immediately, the larger picture of the royal palace faded from the wall, and a still more detailed reproduction of one of the interior rooms took its place. Then, slowly, he turned a pointer of a dial on the box, and, as he did so, one after another of the other rooms of the rambling collection of buildings appeared in turn. Finally an exclamation from the swarthy Abyssinian who had watched every move with a gasping wonder, stopped him. Upon the wall was the picture of the royal conference room, in which Lidj Tassari Makonnen always deliberated with his more important rases, or chiefs, upon all matters of state that required a consultation.

Then Sam turned with a lordly air, and faced his boss.

"When was this conference held at which the Abyssinians made their determination to fight?" he demanded.

"My information is that it started at eleven o'clock by their time yesterday morning, and that it lasted until six o'clock in the evening," Mr. Gordon-Cummings responded meekly. "I understand that the final decision was made at about five in the evening."

"Five in the evening by their time, would be 9:38 in the morning by our sun time, wouldn't it?" Sam remarked.

Then he turned on the Abyssinian like a savage fury.

"Listen you!" he cried. "Your masters will show up in that picture presently, and they will talk. You see that you keep your head, and you listen to what they say, and you interpret what they say to us so that we can understand. Savvy! If you make any mistakes, your people will be no more."

Then Sam glanced hastily at the big "Astronomical" clock to see what time it was, and then quickly set a small clock in his box at "10:56:12 A. M." of "Wednesday" in the year "A. D. 2029." Then he connected the clock with the interior works. Then he turned the clock back to "9:28:00 A. M." of the previous day.

In another moment, a score of wild-looking figures appeared seated around the conference table in the conference room. Prominently in the foreground, was Lidj Tassari Makonnen himself. The fact that they were all talking excitedly at once, was plainly audible—but what they were saying, was to Sam and Mr. Gordon-Cummings merely a jumble of noise.

The Abyssinian, at the first sight of the apparition, had prostrated himself in an attitude of adoration!

But a swift kick on his posterior from Sam, quickly aroused him to his duties.

"Listen, you fool, and tell us what they say!" he shouted.

"Him say," the Abyssinian finally mumbled incoherently as he trembled so violently that he could hardly talk. "Him say—him what is the king of kings—him say: 'We die fighting, or we die slaves! As for me, I die fighting!' That what him say. And the rest, they shout 'Us too!' That what they say."

With the lordly gesture of a world-conqueror, Sam turned and faced his boss.

"That's the little invention I wanted to show you two days ago when you were sleeping or something on the job and couldn't be found," he snapped. "If you had had this little instrument in working order yesterday, you would not have had to guess at things from the unreliable reports of unreliable spies. Wherever there's electric wires into the interior of any building, this little instrument, in connection with a regular "Electro-Visional" apparatus, steps right in and reveals everything that is there. If you want to

know what has transpired at some time previously, you can, if you know the exact time at which it happened and are fortunate enough to catch the visional air-waves before they have escaped from the room, reconstruct the past. In this case we were particularly lucky. The Abyssinians are habitually averse to fresh air in their domiciles, and so the visional air-waves had had little chance to escape. However, this is all beside the point now. You know the truth of the situation at last, so what is it that you want done?"

The Proposition

MR. GORDON-CUMMINGS squared himself deliberately in his chair, extended his left hand palm upwards with a motion that was peculiar to him whenever he wished to particularly emphasize something explicit he was saying, and punctuated his remarks by repeatedly jabbing the fore-finger of his right hand into the palm of his left.

"The proposition is very simple," he said with a deliberate emphasis. "Give the Abyssinians a million of our new two-passenger airplanes, together with such equipment in light machine guns and ammunition as they are short of, and with you handling the planes with a battery and assisting with our new 'Electric Flash,' they should wipe out all three armies of the English, French and Italians on all three of their fronts in two or three days after you get everything prepared. The total cost of planes and equipment should be under eleven billions. We will accept Abyssinian bonds for the bill (the bonds to bear ten per cent interest, which is the best we can do considering the risk) if they will give us a blanket concession on all mineral wealth in their mountains, outside of the few mines their own people are already working. They will get credit for a ten per cent royalty on all mineral taken out, which should take care of the interest on their debt. Besides, we will build all roads necessary to get to the mines, which alone will be worth the cost of the whole thing to that roadless country."

"What is your idea of the general plan that should be pursued in the final battles, after we get everything ready?" Sam asked with a puzzled frown on his face. "You know their military experts don't know anything about our planes, so I'll have to use my own wits in everything."

For a moment Mr. Gordon-Cummings stared at Sam in surprise at the question.

"Well, you are dumb this morning!" he snorted at last. "Haven't you got the cobwebs out of your head yet? That bootleg stuff will get you yet. Mind what I tell you!" And then, as an afterthought, he added: "But I suppose you are thinking of that fact that England, France and Italy have taken advantage of the present international situation, and, not being afraid of complications, they have concentrated more soldiers on the three fronts against Abyssinia than there are men, women and children all told in the whole country. And they are pretty well supplied with airplanes and everything else, too. But you get those papers all signed up in proper shape and the stuff all over there, and you will find the rest as simple as pie."

"I'll have the papers all signed and everything straight inside of an hour," Sam retorted airily. "I'll just turn the clock on this box of mine—what are we going to call this new invention of mine, anyway?—I'll turn the clock ahead again to the present time, and you can watch the whole proceedings. I'll also attach your 'Radio-Photo-Dictograph' so that you can catch and preserve an authentic record of the whole transaction, so that you will have it if you ever need it. And I'll have all the stuff over there before daylight tomorrow morning, if you get it together here so that I can get it."

Mr. Gordon-Cummings gave Sam one sharp look out of the corner of his eye.

"You go ahead and get those papers signed," he said, "and I'll have your battle plan typed out for you by the time you get back."

"All right, but shoot a thousand planes up onto the roof for me to take along with me," Sam demanded. "I want to go to my office for a few things, but I'll be up there all ready to hop off in about two minutes."

Exactly two minutes later, Sam bounced out onto the roof carrying an ornate suit case in his hand. Upon the roof a thousand suit cases of a similar size, but absolutely plain in design, were already stacked. Around the suit cases, a small army of rough-looking working men were gathered, ready to make quick work of the handling of them.

With a single glance to see that everything was ready, Sam stepped briskly over to the largest of the various hangars that dotted the roof, pushed a button, and the front doors flew open and a huge gleaming copper monstrosity trundled heavily out on a truck. It actually was of solid copper which had first been tempered by the recently re-discovered process of the ancients, and then had been repeatedly "Electro-retempered" by an entirely new process. Otherwise, it could never have withstood the violent test for which it was designed. In shape it looked like the old Biblical Ark of the Covenant, but it had a heavy prow like a battering ram. Upon either side of the prow, the name "Electric Flash No. 1" was emblazoned.

Off to Abyssinia

NEAR the center of the side of this monstrosity, Sam pushed a button and a large door flew open with a "pop," showing that it had been released by springs from an air-tight fitting. Entering the passageway into the interior of the thing which was thus revealed, he switched on the electric lights and found himself in a large compartment of flexible glass—the glass having been likewise "Electro-retempered" so that it was absolutely unbreakable—which had been "blown-into" the other copper shell in such a way as to practically surround itself with an absolute vacuum. The comparatively few necessary contacts with the exterior shell were elaborately insulated.

The job of storing the one thousand suitcases within this "Electro-retempered" glass compartment was soon disposed of, and then Sam set the indicator of an "Oxygen Supply" apparatus at "One Person," yanked the lever which started it to going, and pushed a button which closed the door with a bang.

Next a turned pointer on the indicator of an "Interior Temperature Regulator," and a pulled lever, started that apparatus going at a 65-degree adjustment, another lever started the "Electro-Visional" to operating, and a third connected a small dynamo with the "Atomic-energy Reservoir" and started it to supplying the comparatively trifling electrical needs, while a fourth completed a similar direct connection with the rest of the intricate mechanisms and a fifth released electrons of atomic energy from the basic atoms into the "Atomic-energy Reservoir" to maintain the parity of the supply.

Seating himself in an upholstered chair, he then pre-

pared himself for quick and decisive action. With one hand he pulled down the "Helicopter" lever, and, through the "Electro-Visional," saw a huge "Electro-retempered" solid steel corkscrew-like device, which had a flange that was fifty feet deep in the groove, shoot into the air. Setting its regulator at "Half-speed," he touched a button and began to ascend slowly. When the "Altitude Indicator" registered "1000 Feet," he turned the regulator into "Full-speed" and finished with a rush. When the "Altitude Regulator" registered "20,000 Feet," he shut the helicopter down to "Maintenance of Altitude" speed, pulled another lever which released another corkscrew-like device from an underneath pocket, untelescoped it and shot it down to its full length going at full speed "In Reverse"—which acted as a drag upon his upward flight and finally brought him to a full stop at "22,000 Feet," when he snapped it back into its pocket where it roared noisily but harmlessly.

Turning now to the "Electro-Visional" dial, he threw its clutch into the "7060 Mile" circuit, picked out with his microscope the eucalyptus forest upon the southern slope of the Entotto hills which all but hid the city of Addis Abeba, stuck one of two fine needles attached to a delicate copper wire into this point and stuck the other into "Local"—which last he knew was permanently adjusted to a radio connection with the gigantic dynamos at Niagara Falls. Then he set the regulator of the "Electric Flash" at ".037 Seconds," switched on a connection between it and the regulator of the helicopter, shut his eyes and pulled the lever which collapsed the latter back into its pocket—and, as the heavy copper plates banged shut over it, the whole thing was seemingly enveloped in a vivid flash of lightning, and, in spite of the intricate system of "Shock Absorbers," he was nearly yanked in two as he was suddenly projected through space at the rate of 6,000 miles a second.

And then, as if it had been a reflex of the original "yank," there came a violent "tug" as a third corkscrew-like device automatically shot out of its pocket in the rear going "In Reverse" at full speed. Just as the "Speedometer" slowed down to "800 Miles per Hour," Addis Abeba itself showed up in the "Electro-Visional" as being directly underneath, and, with frantic energy, he yanked down the "Plane-wing" lever which untelescoped the "Electro-retempered" steel biplane wings from their pockets on each side, and shot them out to their full "spread" of 150 feet and snapped them rigidly into place. Then he yanked another lever which started him to spiraling straight down. At five hundred feet from the ground, he set the helicopter going at "Landing" speed, yanked the plane wings in with one hand and shot the helicopter aloft with the other, and settled easily upon the ground within the court enclosure of the Gebi, or royal palace, itself.

Ten minutes later, he was explaining to Lidj Tassari Makonnen and a select few of his Rases, the details of the diminutive, collapsible, two-passenger biplane which he insisted would prove their salvation. Placing the ornate suitcase he had brought with him in the middle of the floor, he opened it and took out a compact mass of glistening steel. Then he proceeded in a rapid, concise, business-like manner with his demonstration.

"The best way to give you a complete idea of the whole thing, is to imagine that I am actually making a flight with it, and then to go through with the regular routine that I would go through with if that was the case," he said with a professional brevity. "This is a two-passenger plane. We make a one-passenger plane which is smaller, but the two-passenger size is the more popular one. You will notice that it is folded and telescoped into a compact mass which fits the suitcase nicely. The whole thing weighs less than ten pounds. It is constructed throughout of the latest improved 'Electro-retempered' steel. The tensile strength of this new metal is so great that, although the wings have been rolled to the thinness of gold plate, they have withstood a factory test of one million pounds to the square inch. Therefore, the other gossamer-like parts, some of which are so delicate that it requires a powerful microscope to detect them, are amply sufficient in actual strength.

Suitcase Airplanes

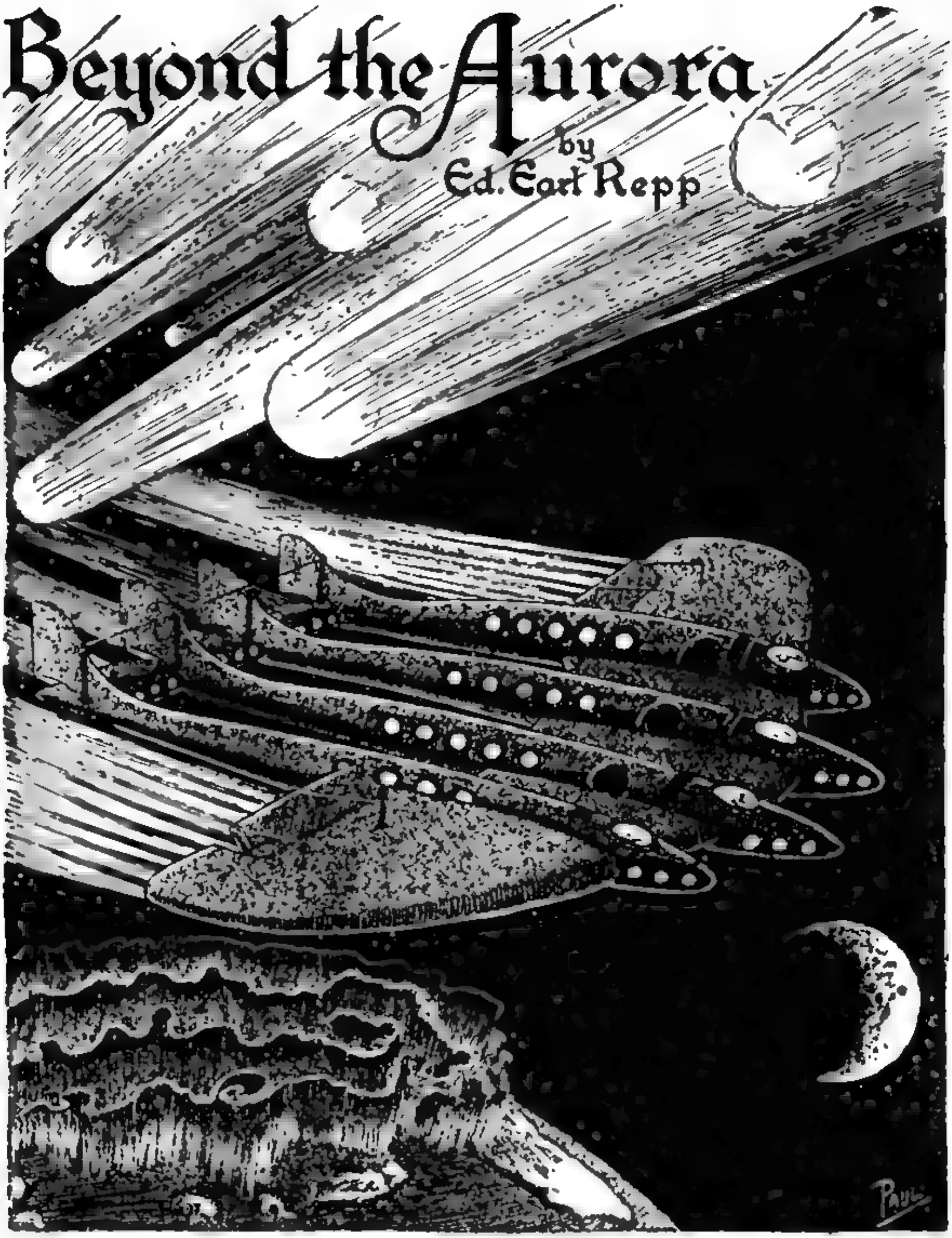
"NOW, if I am to make a flight, the first thing I do is pull this little lever; it releases all catches throughout the entire machine, and the wings promptly unfold and untelescope and snap rigidly into place, while the body also unfolds and untelescopes into its proper shape—and, as you see, we are now ready for the actual flight. Next I take the aviator's seat over here, and push this little button. That connects the machinery with the electrons of atomic energy which operate the whole works. Then I pull this little lever marked 'Helicopter' which connects that contrivance with the basic power, and starts it to revolving, telescoped and folded up as it is, within its enclosed pocket on the top. Then I push the 'Half-speed' button in its bracket, and the helicopter promptly shoots aloft going at slow speed and I start to rise from the ground. I can develop any speed I wish in my ascension up to five hundred miles an hour. This is made possible by the peculiar, corkscrew-like shape of the thing, which is in fact a simple ten-fold multiplication of the basic principle of the original propeller. All the other propellers are also of a similar design. When I have attained the desired altitude, I punch the 'Flying Speed' button of the forward propeller, pull its little lever which shoots it out in front, and, when I have actually attained the flying speed, the helicopter automatically collapses into its pocket and I go on about my business at any speed I choose up to five hundred miles an hour. If I want to stop anywhere, I shoot the rear propeller out behind going 'In Reverse' at full speed which acts as a brake, and the moment that I lose actual flying speed the helicopter again automatically shoots aloft going at 'Maintenance of Altitude' speed. If I wish to remain where I am, I merely leave the thing alone and stay suspended in the air. If I wish o land on the ground, I reduce to 'Landing Speed'.

"Within the works, there is a radio attachment which enables anybody within one hundred miles to send up the plane and control its flight as if they were actually in the plane itself, by using this small battery which goes with each machine. For our particular purpose, however, I propose to use a much larger and more complicated battery which I have in my 'Electric Flash' machine. With this I can handle a million planes, and by using different wave-lengths in different sections of the battery corresponding to similar adjustments that have previously been made in different divisions of these million planes, I can send the different divisions in different directions at the same time and handle them independently of each other. We propose

(*Continued on Page* 459)

Beyond the Aurora

by
Ed. Earl Repp



The great ship heeled under the sudden pressure, like a huge bird in graceful flight. The *Tobias Wollock* plunged downward at an abrupt angle to get out of the path of the oncoming meteor cluster.

BEYOND THE AURORA

By the Author of "The Radium Pool" "Beyond Gravity" "The Invisible Raiders"

"WELL, Captain Wollack, I suppose you are going to resign now and devote your time to the pleasant leisure of a man of wealth and position. Is that it, sir?"

Colonel Brigham, grizzled chief executive of the Federal Aero-Police, chewed savagely, the end of a cigar and glared across his desk at the smiling, clean-cut features of Captain Milton Wollack, youthful commander of the famous Mid-West Division.

"But tell me, Wollack," the executive continued, "how you came to inherit that $50,000,000. That's a lot of money for a youngster like you to play around with!"

"To make a long story short, Colonel," the captain said after a moment, "I'm not going to resign from the Federal. No, not by a damn sight! As for my inheritance—you have probably read the newspapers concerning it. You see, there are documents in the family telling of an eccentric ancestor of mine who invested $20,00 in securities in 1851. His will had a proviso in it that the money was not to be distributed for exactly one hundred years. That investment has grown to the staggering sum of $50,000,000. Now the time is up and I am the lucky descendant to fall heir to it. No, Colonel, I'm going to stick to the Aero-Police! I have no desire to become a gentleman of leisure. There might be another gang of invisible raiders to clean up, some time or other, and I need the excitement!"

"Well, you certainly cleaned up that nest of invisible pirates* two years ago!" the executive said, abstractedly.

"I'll never forget the fight we had with them" the captain replied with enthusiasm: "That was a peach and no mistake! Thanks to Professor Standish for making it possible for us to detect them through his invention of the 'Radio Eye'!"

"It was a good bit of strategy on your part too, to hide above the noctiluminous clouds until the raiders got right below you!" the colonel warmed.

Captain Wollack hummed softly to himself and surveyed his chief affectionately.

"Strategy and victory go together, Colonel," he said, "but I was damn glad when the gang leader was behind the bars! He was too tricky for me—too shrewd a crook to be left loose!"

"Yes," replied the Colonel, nodding, "he should have received a heavier sentence. The government thought it was playing square with him by giving him only a ten-year rap in exchange for the formula for making aircraft invisible. He got leniency alright, but Sharkey is the sort of a man who cannot be kept behind bars."

"It's hardly likely that he'll try to escape," Captain Wollack said, leaning forward: "According to reports he's been a model prisoner during his first two years."

"Model prisoner, yes," the Colonel nodded, scowling, "but I'll wager that he's just biding his time. Fooling everybody with his contented attitude. By the way, what do you intend to do with all that inheritance money?"

ED EARL REPP

The Captain grinned and drew from his pockets a sheaf of papers which he laid flat on the desk. He eyed his superior speculatively.

"It may sound funny to you, Colonel," he said, "but I'm going to build an airship that will fly higher, farther and faster than anything on this earth has ever gone—with the exception, of course, of light and electric current!"

The colonel's brows arched and then lowered in a scowl.

"What do you know about building aircraft?" he asked: "You're a man-hunter, Wollack, not an expert on aerodynamics! You'd better stick to that!"

"All the same," replied the captain, "here's what I'm going to do first of all!"

The executive leaned forward to regard the set of plans which Captain Wollack spread open. With a finger the younger official traced the outlines of an aircraft in blue print, explaining as he went along, the various features of the ship. The Colonel grunted when he explained the specifications of four huge, bullet-shaped bodies evenly spaced, for greater equilibrium, in the central section of the plane's expansive aerofoils. The latter stretched for a considerable distance beyond the streamlined bodies, and the tails were joined together by an enclosed passageway.

A feature of the ship's surface structure that astonished the executive was thirty-six tube-like objects protruding from beneath the aerofoils. The tubes were arranged along almost the entire length of the ship's monoplane-type wings. The peculiar absence of air-screws anywhere in the plans caused Colonel Brigham to survey his subordinate questioningly.

"You've designed a trim looking airliner here, Wollack," he said, "but how the devil do you intend to make her fly? You've overlooked her propulsion mediums!"

IF the money were forthcoming, we could already construct a rocket plane that would give us speeds far beyond anything we now have. The thing no longer is a theory or one of these fantastic dreams of a decade ago.

In the present story, our versatile author has tackled the problem of the rocket plane in earnest, indeed with a vengeance. Incidentally, there is no reason why the things that have been pictured here so vividly cannot come about to pass sooner than perhaps we all suspect.

And while the science-aviation is of a high type in this story, the author, as is usual with him, has packed the story chuck-full of action and adventure that makes you follow the developments breathlessly.

This story we warmly recommend to all.

*("The Invisible Raiders," in October AIR WONDER STORIES.)

"Not a bit of it, sir!" the captain said: "I'll explain it to you. Professor Standish designed the propulsion system. I've seen his models and they operate perfectly!"

"Oh, Standish had a hand in this, eh?" the Colonel said with sudden interest: "I've a lot of respect for science since he designed the 'Radio Eye' to help us detect those invisible raiders!"

"To start with, Colonel," Captain Wollack began seriously: "We are going to introduce the age of rocket aircraft that will cause the rapid banishment of present-day methods of aerial repulsion. In the future it's going to be done by explosive gases shot through tubular driving exhausts, such as you see protruding from under the aerofoils of my ship. The ship, by the way, I have already christened the *Tobias Wollack* in honor of the man who made it possible for me to fall heir to a fortune.

"Of course, as you know, the rocket idea is not entirely new. As far back as 1912, Professor Goddard of Clark University proved that it was technically feasible to shoot to the moon a rocket propelled by explosives. Now Professor Standish has evolved a new explosive driving gas, capable of accelerating either rockets or ships propelled by them to a velocity of 10,000 feet per second. This is a velocity greater by far than any form of older explosive could create; it is greater than the speed of rifle projectiles!"

"That's interesting, Wollack!" Colonel Brigham enthused.

"Thank you, sir," his subordinate replied. "We believe that with such a powerful driving gas, we can fly the *Tobias Wollack* from Washington to Paris in less than an hour."

Wollack's Dream

THE colonel's enthusiasm seemed to wane suddenly. He laughed aloud.

"Don't ask me to believe that tommyrot, Wollack!" he said: "Paris in less than an hour? That's ridiculous, sir!"

"All right, I won't ask you to believe it now," the Captain retorted: "Wait until the ship is built! I tell you, sir, that the *Tobias Wollack* will do better than 4500 miles per hour!"

"At that speed, if you reached it, it would vibrate to pieces, you idiot!" the Colonel argued. "It would burn up in mid-air from friction!"

"But, Colonel, the ship will not travel at that velocity until she gets up in the regions of rarefied air in outer space," Captain Wollack said: "She will do most of her travelling outside the earth's atmospheric envelope where no resistance will be encountered. All existing motors depend upon air for their operation, and present-day propellers screw their way through that air. A rocket ship, with the driving-exhaust principle to propel it, would not vibrate because it has no pounding motors. It is the only method yet discovered for navigating space at high altitudes where there is no heavy air. And since the *Tobias Wollack* will have no motors, it cannot vibrate. Neither can it burn up from friction, because science says there is not sufficient resistance in the regions of rarefied air to heat it.

"One hundred seconds will be required for the ship to get underway from the earth. During that time she will travel at only a fraction of her regular cruising speed. She will take off at an angle of seventy degrees in order to reach the rarefied-air regions as quickly as possible. In exactly one minute and five seconds after she leaves the earth, we calculate, the ship would be fifteen miles above the earth and nearly twenty miles from the starting point. She would have then attained a velocity of more than 4500 miles per hour. I could take the ship off at New York and be in Los Angeles in thirty-seven minutes. In the regions of rarefied air, where the earth's gravitational pull is somewhat less than nearer the globe, a rocket ship could travel with almost unlimited velocity. By travelling so high, there is neither resistance nor the vagaries of weather to contend with. The only objects of threatening nature there are fireball meteors of that altitude. Yet they are not so numerous as to cause any apprehension among passengers of such craft. Means can be found to keep them away."

Colonel Brigham sat like an image of stone while Captain Wollack talked. As the Captain well knew, the executive was a hard man to convince, even when concrete proof was brought into play. He scowled across the desk dubiously.

"Why not tell me that your marvelous *Tobias Wollack* could fly to the moon and be done with it?" the executive put in, contemptuously.

"It is even possible that she *could* fly to the moon, my dear Colonel!" the captain returned stoically: "And it is possible that she *may* visit that satellite sometime!"

"Bah!" the Colonel exploded. "There's a brain specialist across the hall! Better see him on your way out!"

"All the same, Colonel," the Captain said evenly, "I want a month's leave of absence to work with Professor Standish and a crew on her construction."

With a sudden change of aspect that was characteristic of Colonel Brigham he reached across the desk and grasped his subordinate's hand.

"I wish you luck, Wollack!" he said. "Go to it! You'll need a month to straighten out your new estate. Take two months if you like!"

Captain Wollack picked up his plans. He saluted and walked swiftly toward the door.

The Dream Coming True

EVENTS were not long in shaping themselves for Captain Wollack and Professor Standish. In a rented shop, housing all the necessary equipment for building aircraft, the two worked ceaselessly on the construction of the giant rocket ship, the *Tobias Wollack*. Every single beryllium bolt and nut, stud and pin, was turned out by expert mechanics under the noted scientist's watchful eyes.

As he worked on the installation of the port ailerons, Captain Wollack's thoughts raced over the final episode in the apprehension of Sharkey and his invisible raiders. In his mind he relived the terrific battle between the outlaw forces and his own, high in the air. He winced when he pictured the pirate tumbling craft to the ground miles below.

"Sharkey was mighty fortunate to have had that invisibility formula to trade for leniency!" he said to himself as he tugged at a wrench.

"What's that you said, boss?" asked a sweating mechanic working near him.

"Just talking to myself, Wilson," he replied: "How are you coming along on the beryllium casing? If you notice the slightest trace of any defect in the plates, throw them off. This ship is going to be rigid throughout and I don't want any roll faults in the surface structure."

"Okay, boss!" answered the mechanic: "I just un-

loaded about a thousand dollars' worth of faulty beryllium. Had air bubbles in the plates. Didn't think you'd want it."

It was Captain Wollack's pride that he knew each of his men personally, and he took effort to hold the open friendship of each and every single man. Despite his high position in the ranks of the Aero-Police, and the possession of the great wealth which had suddenly come to him, he accepted even the shop roustabouts on even terms. As a result he was admired and respected by them all.

Behind locked and guarded doors the *Tobias Wollack* grew with astonishing rapidity. After the first beryllium central braces were laid, the construction progressed even more rapidly than Captain Wollack or Professor Standish had hoped for. Happy and contented mechanics, experts every one in building aircraft, worked hard and sweated, knowing well that bonuses awaited them at the end of the mammoth job.

Two freight car loads of corrugated beryllium plating, rolled to accurate specifications had been used up by the metal workers on the surfaces of the giant rocket ship. The four bullet-shaped bodies of the craft took shape at an early stage and her aerofoils gradually expanded toward completion. Streamlined beyond comparison with any other craft, the *Tobias Wollack* seemed to have done away entirely with the age-old curse of aviation—the "parasitic drag." The ship's trim, pointed noses, her razor-edged aerofoils and the joining companionway at the tails were so constructed as to offer not the slightest resistance more than necessary to even the rarefied air of the higher altitudes, much less the heavier atmosphere of the earth's protective envelope.

Captain Wollack, in charge of the craft's surface structure, congratulated himself and his men when he stood off and studied the huge *Tobias Wollack*. "Here is a tremendous advance in aviation indeed," he said aloud, walking the entire length of the ship's aerofoils. The ship seemed cramped for space, in even the expansive shop-hangar.

The installation of the ship's propelling forces and mechanisms had been left entirely to Professor Standish, whose knowledge and achievements in physics and engineering were second to none in the entire world. Captain Wollack was elated to see that the scientist had progressed even more rapidly with his charge than had the surface crew. With pride the Captain regarded the row of thirty-six projecting tubes of the driving-exhaust system. Like burnished gold the tubes glittered under the aerofoils.

He had actually seen little of Professor Standish during the earlier stages of construction. The scientist, like Captain Wollack, was too wrapped in his work to have much time for meaningless palaver. Each understood what was required of him, and each set to work with a vim that brought the *Tobias Wollack* to completion in record time.

Eventually Wilson sought out the Captain and informed him that the welders were making permanent the final surface plates. Rather reluctantly the mechanic stated that his work was done, half-expecting to be laid off. Captain Wollack at once instructed him to remain on the job at full pay. Wilson thanked him profusely and strode away whistling softly. Captain Wollack walked under the towering aileron laterals on a tour of inspection. The scraping of wrenches and other tools on the beryllium inner structure of the craft told him that men were still working there, although the outer surface was deserted except for two arc welders hovering over the plates on the starboard aerofoil.

On a cot, nestling under the collapsible landing gear that could be drawn into the port and starboard hulls after the take-off, Captain Wollack found his friend Professor Standish. The scientist seemed lost in deep slumber, but the sound of Captain Wollack's footsteps awakened him. He rubbed his eyes sleepily.

"Just had to lie down for a few minutes, Captain," the scientist said apologetically: "I'm not quite so spry as I was a few years ago. We worked all last night on the installation of the reserve fuel tanks. The boys are putting the finishing touches to the two reserve controlling systems—we'll fuel her shortly."

"That's fine, Professor!" said Captain Wollack warmly: "But it wasn't necessary for you to work so hard. Better take it easy now. We've still fifteen days to finish her and try her out."

Professor Standish shook his head.

"I've got to make a few changes in the main control units," he said: "The automatic lateral-control system doesn't respond as perfectly as I want it to operate. At the terrific velocity of the ship, a powerful control will be required to operate the laterals. Even the slightest fault with the systems may cause disaster. That's why I insisted on the two reserve-control units."

"How about the oxygen-compression units?" the Captain inquired.

"No need to worry about that. I've insulated the interior of each cabin and the tail companionways doubly, so that they are all airtight except for the discharging vents," the scientist declared: "You'll have plenty of fresh air and breathing space."

"I'd hate to die from lack of air a couple of hundred miles above the earth." Captain Wollack laughed.

"The oxygen-compression units will give you all the protection you need in that line," the professor said: "But there's one thing that I'd like to add to the *Tobias Wollack*."

"What's that?"

"A velocity-reducing valve to check speed in landing. The work will take but an hour and I've already prepared for the attachment of a forward projecting tube-exhaust to the central explosive manifold. All I need is a 33-foot tube, elbowed at one end and flanged. The manifold is ready to accommodate it. Control valves and all other accessories are installed. The tube will give you a better velocity-ratio than now; because you can fly the ship within ten miles of a landing at regular cruising speed and then drop down to earth slowly under the forward resistance of a reducing exhaust."

"Well, suppose you knock off and have dinner with me," said the Captain.

The scientist yawned, stood erect and flexed his biceps.

"I'd like to very much, Captain," he said, "but I'd rather stay and get the *Tobias* ready for her first flight tomorrow. You run along! If you're coming back this way you might bring us some sandwiches, will you?"

Tired and worn as he was, Professor Standish returned to work at once. The Captain discarded his overalls and quit the shop, glad indeed, to get out in the open again; for the interior of the hangar was a virtual hothouse. It was stifling, even after the sun had set.

Captain Wollack marvelled at the seemingly unfailing energy of his friend, Professor Standish who, altho fatigued, elected to remain in the stifling shop

with three selected mechanics, to finish up the last shreds of work that would make the *Tobias Wollack* ready for the morrow's strenuous test program. Breathing deeply of the fresh air, the Captain jumped into his roadster parked near the hangar. For half an hour he drove the speedy little machine over open highways; and then, finally, sought out a cool-looking restaurant nestling under gently swaying poplars, some twenty miles from the stuffy shop.

CHAPTER II

What Wollack Overheard

THE restaurant was well-filled at that hour but Captain Wollack soon found himself seated at a table near a group of boisterous men. As he seated himself at the table, the men became quiet and talked in low, subdued tones.

A white-coated waiter glided noiselessly to his table. He laid down a newspaper and set a glass of water before the official who gave his order without hesitation. Quickly he glanced over the front page of the *Post* and opened it. What he saw there caused him to emit a smothered oath. The whole second page was devoted to the *Tobias Wollack!* As he read in the bold type the various details of the construction of the ship and its readiness for flight he wondered why Professor Standish had given out these statements. Or was it the scientist who had informed the press? Captain Wollack was incredulous. He was aware that Professor Standish had never made statements publicly until his theories were actually proved by successful demonstrations. But there were his words in black and white! The Captain fumed as he read a paragraph.

"Professor Martin Standish of the Department of Physics, Washington University, is reported as stating that the *Tobias Wollack* will be capable of flying at the unbelievable speed of more than 4500 miles per hour. Considering the past achievements of the Professor in physics, many experts believe that he will actually succeed in driving the craft at that tremendous velocity. The great ship, it was announced early today, is to be fueled with twenty tons of propulsion gases composed of chemicals known only to Professor Standish. At a velocity of 4500 miles per hour, twenty tons of the gas is calculated to be more than enough fuel to carry the craft on a round trip to the moon, should the builders decide upon such an awe-inspiring attempt."

In the center of the page, Captain Wollack recognized a four-column photograph of the *Tobias Wollack*. Over either aerofoil were inserted small vignette pictures of himself and Professor Standish. He swore at the thought that someone employed in the hangar had permitted newspaper photographers to picture the great rocket ship, and at the looseness of some tongue which had broken the secret of the ship's construction. Captain Wollack had jealously guarded the secret for more than a month, for reasons which he knew only too well. He decided suddenly, that someone had literally sold him out for a price.

He shot a rapid glance at the group nearby. They had their heads together to have a conversation in low tones. Although he was certain that he had not been recognized he buried his head in the paper again to hide the rage that sent hot blood rushing to his features. One of the men passed a remark to another. The Captain distinctly heard it and winced inwardly.

"Sharkey's got a head on him, brothers!" the man whispered: "He ought to be near here by now!"

"Sharkey!" Did the man mean *the* "Sharkey," the cunning outlaw whom he, Captain Wollack, had personally captured after the mid-air raid on the air freighter *Jupiter* two years before? Was this "Sharkey" the ringleader of the band of pirates flying invisible ships, which the Mid-West Division had broken up? Captain Wollack wondered. He recalled Colonel Brigham's warning concerning a possible escape from prison. The time was ripe for that escape, the official regretted, if the famous air-pirate actually planned it! At any rate, Captain Wollack refused to get excited over what still seemed an impossibility. Yet he decided to keep on the alert for further remarks of any in the group. He laid the newspaper on the table and to make it appear accidental he upset his half-emptied water glass on it. The water seeped through and he stuck a thumb into the dampened pulp. Making believe that he was reading the paper intently, he stared through the hole and studied the features arrayed around the table near him.

All were dressed in the height of fashion; although one rather handsome young fellow wore regulation flying breeches and boots, as though he had just dropped down out of the sky in a plane. There were oval rings around his eyes, proving that he had worn tight-fitting goggles very recently. The Captain speculated upon this fact.

Through the impromptu hole he had made in the newspaper, the official regarded them with the keen scrutiny that made him expert in remembering faces. But he failed to recognize a single one of the group. With the mention of the name "Sharkey," the Captain began to ponder. Had the aero-police actually succeeded in breaking up the gang of air pirates two years before; or had they failed to apprehend them all, as had been believed?

A man leaned forward and whispered to his companions. Captain Wollack observed the move and attuned his ears to the words that followed.

"Wilson says that the ship'll be ready tonight," the man hissed in low undertones. "Smart feller, Wilson!"

"Shark don't think he's so good!" said another.

"No? Why?"

"Hard feller to depend on in a pinch," replied the second: "But he's been doing pretty good work for us lately, though!"

Captain Wollack startled at the mention of his mechanic's name.

The man leaned forward again. He was high-strung and nervous.

"Well—if Sharkey don't appreciate anybody's work more than that, I'd better get off the wagon," he sneered.

"Don't be a damn fool, Wick!" said a heavy-jowled companion: "It's every man for himself in Shark's game and them with the most guts gets the most spoils. You'll get yours, don't worry!"

"Do you think you could pilot *Tobias*, Wick?" asked the pompous man, cocking an eye at the man in flying raiment.

"What do you think I am? An Angel?" the aviator replied: "I thought the boss was a master pilot with any kind of aircraft!"

"He is!" the other said, "but he wants a relief man."

"But I thought——"

"You're always thinking, Wick!" the other interrupted. "But don't think so damned loud that everybody'll hear your thoughts! Of course we'll take them two

with us! You don't think that Shark's gonna let 'em stay behind and build another ship to take after him, do yuh?" Captain Wollack did not hear the latter. His waiter had arrived with his order, and in the clatter of dishes the official had failed to catch the words that would have been of great importance to him. He began to eat with seeming great gusto, appearing to pay not the slightest attention to the group. Never, however, would he forget the faces surrounding that table! They were stamped indelibly with those of countless other rogues in the memory of the official!

Eventually Captain Wollack lifted his eyes from his plate and tipped a coffee cup. A waiter was handing a note to the heavy-jowled man at the other table. Without glancing around the man opened and read it, then motioned to his companions to follow him out of the cafe. Captain Wollack drained his cup and motioned for his check. He handed a bill to the waiter, donned his hat and sauntered slowly toward the door. Flashes of lightning pierced the heavens as he stepped out. A large sedan pulled away from the café and rapidly disappeared into the night.

A Little Acting

WHEN Captain Wollack arrived at the shop on his return from dinner he found Colonel Brigham pacing the floor and cursing roundly. It was ten minutes before eight o'clock when he arrived and it took exactly ten minutes for the tempestuous executive to say just what he thought of him in no uncertain terms. Professor Standish and his three mechanics stood off under the port aerofoil tip of the *Tobias Wollack* and watched the scene with apparent amusement.

"You told me that I could get in touch with you at any time, Wollack!" the Colonel raged: "I've been looking for you everywhere! Explain yourself, sir!"

Captain Wollack grinned sheepishly.

"I left at six o'clock for dinner, and a little fresh air, Colonel," he replied: "Is there any harm in a man wanting fresh air and something to eat?"

"There is, sir!" Colonel Brigham fumed, "when you are supposed to be at my beck and call!"

"Why, what's happened?"

"Do you mean to tell me that you are not aware that Sharkey fomented a wholesale jailbreak and escaped?"

"Well, what's that got to do with me now?" Captain Wollack said nonchalantly, but winking guardedly at the raging executive. "I'm off duty on leave of absence, sir!"

Captain Wollack hadn't dared to hope that the Colonel would grasp the significance of his winking eye and he was surprised when the executive paused with upraised fist and nodded queerly. He let his arm fall in a manner that the Captain accepted at once as mimicry, and spat out an oath.

"Why—you—you!" the executive shouted. "I thought you told me that your money would make no change in you! Do you dare to stand there and tell me that you refuse to return to duty?"

"I shall return as soon as my leave is up, Colonel!" he said. "Not before!"

With that Colonel Brigham pulled his hat low over his eyes and strode swiftly out of the building. Captain Wollack hung his head for an instant.

"Maybe I've been a little hasty!" he said to himself aloud, so that the others could hear: "Colonel! Just a moment, sir!"

He raced to the door and disappeared. The Colonel was waiting in an official machine.

"I had a lot to say, Colonel," he said, leaning through an open car window, "but I wanted to keep mum for the benefit of one of my mechanics whom I've learned is in cahoots with Sharkey."

"I thought so, Wollack, when you didn't make a comeback at me," the executive growled: "What do you know?"

Captain Wollack recounted the words he had heard from the group in the café.

"Good work, Wollack!" the Colonel said warmly. "I'll learn someday to recognize your resourcefulness! Sharkey dropped from sight in the melee at the prison. It's another feather in your hat to get him before the ground men have a chance to cuff him. Give the Federal all the credit. I'll have a dozen men here in an hour!"

"Oh—we'll get him, alright, Colonel!" the captain said grimly.

Colonel Brigham gave an order to his chauffeur and the machine raced down the dimly-lighted thoroughfare away from the isolated hangar. The Captain returned to the shop, appearing dejected. Professor Standish came up to him.

"Catch him in time, Captain?" he asked.

"He has gone, Professor!" Captain Wollack said, forlornly. "I guess this means the end of my commission with the Federal Aero-Police! Oh, well! I'm tired of it anyhow. I'd like a long rest."

"The Federal won't be the same without you, Captain. Better think twice!" admonished the scientist.

"It'll get along. Never fear for that!" replied the Captain: "Your nephew Jack is in command of the Mid-West during my leave."

Suddenly he remembered that he had forgotten, in his haste, to return with the sandwiches the scientist had asked for. He looked up.

"Hell!" he said, "I've forgotten your lunch, Professor!" Turning to Wilson, he continued, "Here, Wilson! Run up the street and get something to eat for all of you! Hurry back, though!"

The mechanic accepted a proffered bill and went out. Captain Wollack motioned the others close to him. Professor Standish's face displayed his wonderment The captain studied the faces of the mechanics for an instant before he addressed them. Convinced of their honesty, he explained in detail just how things stood. They stared, open-mouthed. The scientist grunted in alarm.

"I'll grab Wilson when he comes back," the captain told them: "I believe Sharkey plans to steal the *Tobias Wollack* tonight to make his getaway. If I can make Wilson talk we may be able to fight the gang off. I'll arm the three of you and swear you in as Aero-Police reserves"

Scarcely had Captain Wollack passed out sidearms to the two mechanics and to Professor Standish than Wilson swung open the shop door. He deposited a bag of sandwiches on a bench and walked toward the Captain to return the change. As he reached out there came the sound of a metallic snap and Wilson found himself firmly handcuffed. He stiffened and his face paled. He jerked back, sending the silver flying.

"What's the joke, boss?" he asked, controlling himself.

Captain Wollack jerked the handcuffs and Wilson groaned as the steel bit into the skin of his wrist.

"No joking about it, Wilson!" the Captain said, accusingly: "I've got you just where I want all the rest of Sharkey's gang! Don't try to stall!"

"Why—why—you ain't got anything on me, Captain," faltered the mechanic: "What's the idea?"

"Oh, haven't I, Wilson?" the Captain followed him up: "So it was you who allowed newspaper men to photograph my ship and announce its completion to tip Sharkey off that his time for escape had arrived, eh? Yeah, Mr. Sharkey's man, Wick, told me all about it today!"

"Wick? Who the hell is Wick?" Wilson managed to hide his amazement behind a blank stare.

Captain Wollack frowned. He suddenly found himself thinking that perhaps this was not the right Wilson after all. But he decided at once his plans to force the mechanic into betraying his alliance with Sharkey's gang.

The Fight in the Hangar

THOUGH hardened as he was, to the ways of criminals, the captain did not feel justified in putting the mechanic through a third degree. Yet with a sudden rage swelling in his throat he twisted the handcuffs cruelly. Wilson cringed and sank to the floor, face blanched at the pain of the biting steel.

Coherently he bubbled his innocence, avoiding blankly a string of questions which Captain Wollack shot at him in hopes of catching the mechanic off his guard. But try as he might, the captain failed to wring from the lips of the man any information of value. Eventually he lifted him to his feet and pushed him none too gently toward the bench. Wilson sat down sullenly, casting significant glances at the Aero-Police official.

Handcuffed, the mechanic sat on the bench with Captain Wollack, Professor Standish and the other two men, but refused to partake of any of the sandwiches which the captain offered him. He confessed that events had caused his hunger to flee. Captain Wollack did not doubt it, but he had a feeling that the man was not as sincere in his loyalty to him as he had babbled. He would bear watching at any rate, the Captain decided, reaching over to unlock the cuffs. After all he did not want to burden himself with holding a man on mere suspicion. Perhaps Wilson would yet betray his hand. Time enough then, to jail him.

"Well . . . Wilson," the Captain said, taking off the cuffs and pocketing them. "If I've made a mistake in identification I'm sorry. But you can either remain or take your pay check and quit. Either way suits me."

Wilson eyed the Captain shiftily.

"I—guess I'll stay, boss," he said, his lips curling into a sneer.

If Captain Wollack had seen the curling lips of Wilson, he did not show it. He turned toward Professor Standish for a word. The scientist and the other two mechanics were munching the sandwiches with relish. Rapidly they vanished, Captain Wollack looking on while the others consumed them. After the heavy dinner he had taken at the cafe, the Captain had no further desire to eat; he ignored Wilson, leaving him to his own thoughts.

Then suddenly, as the professor opened his mouth to say something, his face whitened. He sat rigidly for an instant and abruptly slumped forward off the bench. Captain Wollack stared after him, then switched his eyes to the two mechanics. Almost simultaneously they whitened around the mouth and topped over without a word. It did not take long for the Captain to understand the reason. With a bound he swung away from the bench and faced Wilson.

The mechanic had arose from the bench while the Captain spent a few brief seconds regarding his fallen fellows. He stood crouched.

With a roar of rage Captain Wollack leaped at the mechanic, his hands closed into fists of bone and muscle. Wilson sneered and met the rush with an impact that sent them both sprawling, the mechanic's powerful legs encircling the Captain's waist. The official heaved with all his might, but Wilson clung to him with the tenacity of a boa. His powerful paws sought a hold on the throat of the Captain. The official struggled to prevent it; but gradually the huge hands of the mechanic overcame his resistance and clutched at his jugular.

During the next few minutes, Captain Wollack received the throttling of his life. Wilson's legs, encircled around his mid-section, pinned him to the floor, while claw-like fingers bit deep into his throat. He tried to cry out but his voice seemed to have been shoved back into his lungs under the pressure of the claws that threatened to choke him into unconsciousness. Great, spinning balls of fire seemed to whirl before his eyes and he shook his head from side to side as though to prevent them from striking him in the face. He lifted a feeble foot in an attempt to strike his antagonist. Wilson's fingers sank deeper and, after a few spasmodic twitches, the Captain lay still.

Wilson shook himself loose from his perch on the captain's inert frame and stood erect. He chafed his hands to renew circulation after the cramp of prolonged muscular tension had all but deadened them. He bent over his victim. Captain Wollack was breathing faintly, but breathing nevertheless. Wilson smiled grimly, and looked down.

"Well—Captain," he thought, shaking a finger scornfully at the death-like figure on the floor: "You gave me a swell chance to put you out. But I figured on you eating one of those sandwiches. It's amazin' what a few drops of dope will do to a feller. You had me guessin' for a while how I was gonna lay you out, until I decided to pep up your drinkin' water. This job ought to bring a fat reward from Shark! All we have to do now is to put you aboard old Tobie and fly away with you at the controls to a place where you can't pinch us or build another ship to take you after us. When Shark and the gang arrives we'll bring you to and make you drive the ship away. Maybe to the moon! That all depends on how Shark feels tonight!"

He walked over to the professor and removed a sheaf of documents from his pocket. Searching through them he found the one he wanted and cast the rest away. One of the parchments contained the almost unintelligible scrawling of a scientist. He recognized the professor's heavy handwriting, and identified the paper sufficiently to tell him that it contained the formula of ingredients for manufacturing the driving gases that were to thrust the *Tobias Wollack* through space at 4500 miles per hour or better. Without the formula the craft would have been useless to Sharkey's plans. And there was no telling how soon Professor Standish might pass out of the picture of life, with Sharkey holding the whip-hand.

CHAPTER III

Captured!

WHEN Captain Wollack returned to consciousness he felt a cool breeze blowing on him from some open door. He lay on his back on a hard, metallic floor and stared into an inky blackness overhead. Gradually it dawned upon him that he was lying prone in one of the cabins of the *Tobias*

Wollack. He sat up with a jerk and his head swam at the effort. He closed his eyes to control a whirling dizziness that was sweeping over him. Then he heard a groan beside him. Reaching out, his hand encountered a warm form.

"Is that you, Professor?" he asked tensely.

There was a long pause.

"Wollack, I've been dreaming that you were killed," came the scientist's voice, shaking: "What happened? Lord, what a headache I've got!"

"You were drugged, Standish," the Captain said, peering into the darkness. "I should have had better sense than to send Wilson after those sandwiches. The—"

The captain paused at the sound of sneering laughter coming from the darkness.

"Be more careful next time, Cap!" came Wilson's voice: "I might get nervous and dish out bigger doses. And, boy, what I didn't do to you was a joke!"

"And you'll hang one of these days, Wilson!" the Aero-Police official swore coldly.

"They don't hang men where you're goin', Cap!" Wilson laughed.

Captain Wollack lifted a leg for a sudden spring at the sound. It scraped loudly on the floor.

"No you don't, Cap!" Wilson hissed menacingly: "Shark says to drill you if you make a single false move! He can fly this ship just as well without your help! And I've got two of the biggest guns in forty-eight states aimed right at your glassy eyes!"

"Shut your damned mouth, Wilson!" A high-pitched voice suddenly came from without: "Turn on the lights!"

Instantly the interior of the cabin was bathed in a brilliant white glow that emanated from a system installed by the professor. It embodied a cold-light principle; so that there was little chance of accidentally setting off the reserve fuel supplies by faulty electrical wiring. At the same time, it was possible for the bulbs to operate perfectly for several years without requiring the attention that an electrical system might demand. The brilliant cold rays penetrated every nook of the cabin.

Captain Wollack shot a glance at the open door. In the white glow Sharkey's features appeared like those of a green ghost. The pallor of prison gave him the color of radium green. He leered through the door. Captain Wollack met his stare coldly.

"Well—this is indeed a pleasure, Captain!" the famous scientific-criminal sneered: "I really hadn't expected to meet you again so soon, and under such favorable conditions! Thanks to the genius of yourself and Professor Standish whom I have the great pleasure of meeting for the first time. How are you, Professor?"

"You'll regret this meeting, Sharkey!" the scientist growled, sitting up.

"And how, my dear Professor, may I ask?" Sharkey inquired sarcastically.

"If I'm to operate this ship, Sharkey," said the scientist significantly, "I'll blow the whole bunch of us to hell before I'll permit you to get away with her!"

Sharkey was silent for a moment.

"Even scientists fear death under certain conditions, sir!" he rasped, turning away.

"No more than a filthy dog like you, Sharkey!" Professor Standish shot after him.

But Professor Standish was not yet ready to die; especially at the hands of Sharkey. Nor was Captain Wollack.

Surrounded by grim-faced outlaws, they offered little resistance when Sharkey ordered them to assume positions at the controlling and operating systems of the *Tobias Wollack*.

Seating himself comfortably in a cushioned chair in front of the controls in the main cabin, Captain Wollack wondered what had become of the colonel's detail. He looked at his wrist-chronometer and was amazed to find that it was only 8:45 o'clock. He concluded that the police had not yet arrived, and that Sharkey was losing no time in making good his escape in the rocket ship. And he presumed that his two mechanics were left lying where they had fallen. He had not seen them since Wilson had throttled him so mercilessly.

Resigned to the situation, he twisted the lateral controls for the feel of them. Likewise he tested the aerofoil ailerons. They responded perfectly. He set them at an angle of seventy degrees for the upward take-off and then looked up at a sound. Two of Sharkey's henchmen had entered the cabin and seated themselves at the right of the Captain to maintain guard over him. Wilson displayed two large Atherton pistols as he sat down and grinned. Captain Wollack presumed correctly that Professor Standish was likewise to be guarded constantly at his station in the operating chamber of the rocket plane. He toyed with the aileron-control wheel, waiting for the signal to inform him that the *Tobias Wollack* was ready for flight.

It came all too soon. A buzzer hummed softly on the instrument board. Captain Wollack gripped the control wheel tensely and rested his toes on controlling pedals under him. He shot a quick glance at his guards. They were white-faced. The Captain himself felt a trifle nervous.

Then suddenly there came a terrific roar from the outside. He glanced through an observation window at his side. The *Tobias Wollack* seemed enveloped in fire! The roar suddenly became an ominous hiss and with a tremendous recoil the rocket ship shot upward with such velocity that it sent the two guards hurtling to a far corner of the cabin. The soft back of the captain's seat broke the concussion for him. He smiled grimly, his eyes glued on the instrument board.

Into the Air

IN THE compartment which contained the apparatus for forcing the driving gases into the combustion cylinders and out through the exhaust vents, Professor Standish was beginning to enjoy the ordeal despite the presence of Sharkey and the guards.

The outlaw chief seemed bent on learning every detail in operating the *Tobias Wollack* at that end and plied the scientist with many questions which the latter at first openly avoided. Gradually he began to answer them through sheer pride in the machinery which his keen scientific brain had created. Forgetting temporarily that the outlaws were his deadly enemies, his interest in the rocket ship's maiden flight grew in leaps and bounds. And he talked; for after all Sharkey's knowledge of scientific matters was really interesting if not astonishing for one engaged in outlawry. And Sharkey could be as affable and pleasant as he could be cruel and ruthless.

Almost at a glance the outlaw understood the principle of the craft's mechanism. But altho there seemed to be nothing complicated about it, yet he felt that, if

he were left to his own resourcefulness at present with such a powerful ship, an eventual crack-up would be inevitable. Therefore he plied the scientist with questions to learn every detail of her workings. He already understood the formula for manufacturing the fuel which propelled the ship at the terrific velocity at which she was now flying. Wilson had handed over the important document without hesitation. And Sharkey took time to study it, storing the information in his brain for future use. He literally memorized the chemical ingredients and the proper mixtures as a precaution against the loss of the paper itself. He smiled to himself at the simplicity of the formula.

He had been amazed at first to find that the driving fuel of the rocket ship was not a liquid, as he had previously speculated. At some period in his life he had learned a good deal about chemicals, and it was not difficult for him to see that the gas in even small quantities contained astonishingly great power. He wondered how Professor Standish had achieved the medium for generating the gas and driving it through the propulsion exhausts with such terrific force, and he inspected the ship's mechanism again.

The general system for distributing the explosives from the storage tanks, he soon discovered, was by centrifugal action. Before the generated gases reached the main manifold artery, which ran from a combustion cylinder to the left and to the right under the aerofoils, they underwent a series of explosions. Several cylinders in a perfect row gave the outlaw the knowledge that the gases were discharged intermittently before they reached the driving chamber. In the latter they exploded again, forcing the gas into the manifold and out through the driving exhausts.

At first the criminal had disbelieved the touted capabilities of the craft. Now he stood staring at the instruments arrayed conveniently on a panel. He started perceptibly when his eyes fell on the altimeter, the needle of which pointed to the ship's elevation in luminous type; it hovered gently at the 100-mile mark. He calculated then that the *Tobias Wollack* was well above the earth's envelope of atmosphere and must therefore be travelling at a terrific velocity. His eyes wandered to the velocity indicator. The point had passed the 4500 mark and was nearing a mark far beyond his conception of speed. It paused at 6000 and then moved slowly to higher figures.

He walked over to the row of observation windows and stared out. Instead of seeing a sheet of flame behind the driving exhausts he saw merely eighteen jets of blue, spitting with hissing sound from the vents. Far below lay a huge, dull mass that he recognized as the earth, swiftly left behind as the ship shot upward. He chuckled oddly and gazed upward.

Overhead the planets gleamed like large, polished gems. Never on earth had he seen stars so bright or defined so clearly as they were now. Mars lay like an opal in an emerald setting. Great Jupiter, Venus and Sirius nestled in the deathless heavens like jewels in Urania's crown. Here and there in the higher altitudes of the rarefied air, in the region of fire-balls, clusters of meteors were visible. They shot through the heavens at terrific velocity to pass into the beyond, leaving long trails of fire behind them. And Sharkey's eyes took on a queer light as he saw them. His lips curled and he laughed aloud like one suddenly possessed with insanity.

On to the Moon

IT WAS uncomfortably warm within the *Tobias Wollack*. Professor Standish mopped drops of perspiration from his brow as he watched the gauges. He twisted a valve-control and the rocket ship shot ahead with a sudden jerk. His eyes wandered to the altimeter. The indicator was hovering over the 350 mark and the interior of the ship began to cool; for she was now far within the regions of rarefied air and was rapidly ascending to greater heights.

The scientist was elated. But his elation fell perceptibly when he beheld Sharkey and his henchmen staring out of the observation windows. His brows clouded and he stiffened in his seat. He had almost forgotten the threatening presence of the outlaws while he revelled in the success of the rocket craft. Here, he thought, was the greatest achievement in aviation since aircraft first fluttered from the creative nests of man's brain. And that achievement had to go first to further the aims of a ruthless gang headed by a crazed leader! He vented a muffled oath and clenched his fists until the nails bit into his palms. But he was powerless to change the situation.

As Sharkey peered out of the window he noticed that the earth's dull surface was beginning to assume a cloak of pale luminosity. He scanned the heavens. Far to the eastward, just beyond the rim of the earth, the upper tip of the moon was visible. Almost suddenly it shot into the sky from behind the great sphere below and then the outlaw looked downward. The earth was aglow with a phosphorescent light. Its great bodies of water scintillated like tremendous pools of opalescent fire. Like a thing of menace, the moon raced to meet the advance of the *Tobias Wollack* whose driving exhausts were thrusting her forward at a terrific velocity.

It is a known fact that the moon not only controls the tides and affects seasons of the earth, but it is also believed to have an uncanny effect on the instincts of the comparatively infinitesimal human. Whatever tendencies toward insanity that Sharkey possessed in his powerful, but warped brain suddenly asserted themselves to their fullest. He laughed again in a high-pitch, cackling voice. The sound caused Professor Standish to regard him curiously. Had "moon-madness" taken a firm grip on the man? The scientist pondered thoughtfully. But he was destined to find out the truth soon enough, for Sharkey suddenly strode to his side, his lips curled into a sneer, teeth bared like the fangs of a mad beast.

"Standish!" he cackled: "Get hold of Wollack and tell him to keep this ship headed direct for the moon! We're going to visit her!"

The scientist stood aghast.

"Don't be a fool, Sharkey!" he said, lips tightening grimly: "This ship will never make it! Besides, the moon is absolutely unfit for human habitation even for the shortest period! Don't sign your own death warrant!"

The crazed outlaw poked an automatic into the scientist's ribs. Professor Standish heard the click of the pistol's depressed safety catch. At once he swung to the instrument board and lifted a small disc from a hook over a projecting mouthpiece. He placed the disc to his ear and pressed a tiny button on the panel. Instantly a small screen above the mouthpiece glowed with the grim, set features of Captain Wollack. It was the scientist's first opportunity to test the miniature

television system which connected each chamber of the ship with the combustion compartment.

"Hello, Wollack!" the scientific said into the mouth piece: "Sharkey says to keep a course direct for the moon. Better do it! He threatens to shoot me if you don't!"

The outlaw chief cackled, his eyes gleaming maliciously.

"I've always wanted to visit the moon, Standish!" he hissed villainously as the scientist hung up the disc.

"I tell you, Sharkey," he growled, "you are committing suicide!"

He turned his head to look at the other men. White-faced and frightened, they stood grouped together in the offing. The scientist could hear an unintelligible mumble of words coming from them. Then one of the men stepped toward Sharkey.

"You're not serious, are you, Shark?" the man asked, his hands and lips trembling: "None of us want to take such a risk. Better change your mind and head somewhere else!"

Sharkey's lips curled significantly.

"Who's running things here, Saxon?" he shot.

"You are, of course, boss," Saxon replied, belligerently. He crouched tensely as though he expected Sharkey to spring at his throat. "But we ought to have some say about goin' to the moon or anywhere else! You must be crazy!"

Sharkey emitted the peculiar cackle again.

"You might as well decide that you're going wherever I go!" he sneered.

Saxon lunged forward suddenly. "And you're going to hell right now, Shark!" he bellowed.

If Saxon had noticed that Sharkey still held the automatic in his hand, he did not consider the fact. The bandit leader swung the pistol upward with a twist of his wrist. It spat sharply and Saxon slumped forward on his face.

"You—you devil!" Professor Standish burst out.

CHAPTER IV

"You'll Never See It Again"

SAXON'S inert frame was forthwith dumped through an outward-swinging double floor hatch. As the body disappeared, the scientist muttered a prayer. Sharkey shook with insane mirth as he pictured it tumbling into the depths below.

The supply of oxygen in the cabin almost instantly wafted through the opening. Sharkey stood up struggling for breath. The others coughed spasmodically with strangulation gripping their throats. The scientist held his breath and snapped the hatch to a close. He touched a valve and the hissing sound of air was audible. Rapidly the oxygen tanks refilled the cabin. The compression motors labored for an instant and then hummed softly.

Presently Sharkey accosted the scientist again.

"Standish!" he said, rather seriously, "how long will it take this craft to span the distance between the earth and the moon?"

"About eighteen hours, Sharkey!" Professor Standish replied.

"That's what I calculated," the outlaw acknowledged.

"How did you figure it out?" asked the scientist, wondering how the man had accumulated his knowledge of science.

"Well . . . " Sharkey said. "the distance between the earth and the moon is 240,000 miles, is it not? At the speed of 5000 miles per hour, forty-eight hours would be required for this ship to traverse that distance at regular cruising speed. But, the farther we get away from the earth's gravitational pull, the faster she will travel. And, the nearer to the moon we get, the more assistance we shall get from her gravitational attraction; which, combined with other facts, ought to increase our velocity ultimately to some 20,000 miles per hour. The distance between us is being rapidly decreased also by the motion of the satellite in our direction as she revolves eastward around the earth. So we may even do it in less than eighteen hours!"

Professor Standish smiled, his lips drawn tight across his teeth. He was amazed at the coolness of the outlaw's circulation.

"We might reach the moon, Sharkey!" he said, "but it's a certainty that you'll never return to earth!" That much for its effect on Sharkey's henchmen; but they made no further attempt to stay Sharkey's plans.

"But I understand you made statements that the ship could fly a round trip to the moon, Standish!" the outlaw chief insisted.

The scientist remained silent. It was useless to argue a warped brain out of any plan that had become firmly set within it!

Unarmed and under constant guard as they were, Professor Standish and Captain Wollack had little chance to resist the forces that held them subdued To all outward appearances they had resigned themselves to whatever the future held in store for them. Yet in each seethed a smoulding flame of resentment which needed but one opportunity to fan it into an uncontrollable blaze.

Sharkey with half of his men had long since retired to one of the other cabins to hold council and to rest. Wilson remained on guard over Captain Wollack, and several bandits were stationed to watch over the scientist to make certain that he did not slacken the *Tobias Wollack's* terrific velocity. It was easy to mark the course of the ship merely by watching her noses. They pointed directly at the moon, a trifle to the north, now, from the center.

The satellite loomed up in the heavens like a huge ball. Her mountainous surface was becoming more clearly defined. Long shadows lay to the right of her towering peaks. Her pock-marks, now like yawning pits, seemed to challenge the advance of the rocket ship as though waiting to swallow it up. The planet was brilliant in the glare of the invisible sun. The seething sphere was well down behind the world that created the ship's passengers.

In Captain Wollack's control cabin, Wilson peered tensely at the satellite. It had become decidedly colder and the erstwhile mechanic shivered. He allowed his gaze to wander to the left. In the northern part of the earth hung a vast, wavering curtain lighted brilliantly with the vari-hued shades of the spectrum. It was the aurora borealis. It seemed alive—like a great, flat, headless dragon, weaving in long, determined sweeps above the earth's arctic regions.

As the minutes passed swiftly, Wilson's cool nerve seemed to crumble. Captain Wollack regarded him curiously and his guardmate suddenly got up and left the cabin. Frequently he cast longing glances downward. The earth, like a distant satellite, lay aglow under the spell of the moon's phosphorescence. Often he sent side glances at the captain sitting in the pilot's seat. That the man was on the verge of collapse, Captain Wollack could see easily enough, and he decided to

help break down the outlaw's nerve by well-directed conversation.

"Don't take it so hard, Wilson!" he said suddenly: "But take another good look at the earth! You'll never see it again!"

For long minutes Wilson stared downward before replying. Then he seemed to relax. His hands, which had held two large Atherton pistols aimed in the direction of the Captain, dropped to his sides, muzzles pointing at the floor. His lips quivered and he mumbled to himself.

Captain Wollack's blood rushed to his head when he realized that at last an opportunity for him to assert himself had arrived. But Wilson was not to be taken unawares. As the Captain pressed a button locking the *Tobias Wollack* to a straight, rocket-like course and turned in his chair, Wilson faced him.

"Don't try it, Cap!" he snarled.

The Captain grinned and nodded.

"Was just getting comfortable, Wilson," he lied, innocently.

"Don't you think we'll ever get back?" Wilson asked, satisfied that the Captain had meant nothing by his move.

"I'm perfectly certain we won't!" the Captain said, shaking his head with significance: "Better look long and hard, Wilson! You haven't long to live!"

The Spell of the Aurora

CAPTAIN Wollack turned again to the controls to permit what he had said to soak in. He peered upward through an overhead observation window. What he saw there caused him to grasp the wheel tensely.

Midway between the *Tobias Wollack* and the lunar body had suddenly appeared a cluster of brilliant fireballs! Even at their great distance, the Captain could distinctly see the rushing meteors. He glanced at an instrument. Its indicator hand jumped to the right and hovered at a glowing word. The official started.

"Fire-ball meteors!" he whistled sharply. "A whole cluster of them heading right for our noses!"

Wilson sat bolt upright. His Athertons clattered to the floor. He peered toward the advancing spheres of flame.

"My God!" he groaned, hiding his face in his arms. "We're right in their path!"

Captain Wollack snapped the lock from the controls and twisted the wheel sharply. The great ship heeled under the sudden pressure like a huge bird in graceful flight. The *Tobias Wollack* plunged downward at an abrupt angle to get out of the path of the oncoming meteor cluster. Hardly had she hurtled from the level when a terrifying roar vibrated through the ship. The Captain looked up. A sheet of vivid flame seemed to hover just beyond the rocket plane. It vanished gradually and he sighed with relief. The diminishing uproar was passing into nothingness almost as rapidly as it had come. Wilson slumped and sobbed, inert. His nerve had snapped entirely.

The Captain's eyes fell on the two pistols lying on the floor. His hopes raced. Here at last, he decided, was the opportunity for which he had been waiting. Wilson's arms were still covering his face.

Crouching, Captain Wollack leaped. As he left the chair his left knee bumped the control-locking system. In a moment of speculation on his intended leap at his guard, he had snapped on the lock. Now his knee somehow released it and the *Tobias Wollack* seemed to sideslip sharply. But, midway between his deserted seat and his human objective, Captain Wollack did not dare return to the controls. Despite the sharp angle of the cabin floor, he thrust himself at the man. Wilson, suddenly feeling the slip of the craft, looked up, but he was too late for once in his life, for Captain Wollack's hand had closed on an Atherton. As Wilson's heavy frame hurled toward him, Captain Wollack snapped up the pistol and fired point-blank. Instantly there came a muffled explosion. The erstwhile mechanic straightened and then fell heavily, blood streaming from a gaping hole in his chest.

Her controlling ailerons and laterals left to the mercy of chance, the *Tobias Wollack* suddenly nosed downward at a precarious angle. Captain Wollack was thrown heavily to the floor and skidded along it to the forward tip of the cabin, where he braced himself. He shoved the heavy Atherton into his waistband and tried to pull himself to the pilot's chair. Suddenly the rocket ship pointed the aerofoil downward so sharply that he was thrown into the space between the seat and the controls. Wilson's inert body hurtled after him and wedged him in. Almost as abruptly as she had side-slipped, the craft righted herself again on an even keel, and then seemed to swing to the left in a great circle.

Captain Wollack gave a mighty heave and pushed the dead outlaw's heavy body from him. He grasped the spinning wheel with wet, greasy hands. The craft heeled upward and he was hurled to the floor again, his head striking heavily.

As he lay stunned the *Tobias Wollack* plunged and dipped madly, like a cork on an angry sea. The two bodies in the control cabin were dashed hither and on along the floor. The driving exhausts had shot the rocket ship headlong out of control; minutes passed swiftly but her velocity did not lessen.

And, when Captain Wollack finally regained consciousness and managed to pull himself into the pilot's chair, he discovered that the moon was no longer in front of him. The ship had swung from her course. Straight ahead of him lay the weaving scroll of the Aurora Borealis. He swung the wheel a trifle northward, so that the ship would traverse a wide, circular area, and locked the controls. He started at the sound of a scraping boot behind him. He looked up.

Sharkey, flanked by one of his henchmen, stood leering down at him from the cabin passageway. The Captain's heart skipped as he saw that the outlaw aimed an automatic at his head. The other man was staring at the ghastly form of Wilson, lying near him on the floor.

"I'm going to kill you for this, Wollack!" Sharkey cursed: "You've had it coming to you for a long time now! Thought you could pull the ship off her course without knowing it, eh? And you thought to kill us by your maneuvers! I'm going to pump you full of holes, Wollack!"

The Captain sat rigid. Apparently Sharkey had not seen the meteor cluster and believed that the ship had been deliberately thrown out of control in hopes of dashing the outlaw's brains out against the structural frames. Well, what matter how Sharkey thought now? He would surely blow his victim's head off without hesitation.

"Go ahead and shoot, Sharkey!" Captain Wollack said, "and have it over with! But remember, I've got you covered too. I can get you with this Atherton before I pass out. You'll go like Wilson went!"

The outlaw shot a glance at the prone figure. That was all Captain Wollack needed to permit him to lift

the Atherton's muzzle over the back of the seat. Sharkey saw the move instantly and dropped to the floor. The other man shot a hand to a coat pocket, as Captain Wollack fired at him, and screamed horribly when the bursting high explosives ripped an arm and shoulder from his torso. He dropped and lay lifeless.

Sharkey's automatic spat spitefully. Captain Wollack dropped down behind the chair again, completely hidden from view; but as he dropped Sharkey's slug had creased his shoulder and ploughed a little furrow along his neck. He groaned slightly and shook his head to shake off a dizziness that grasped at him from the stinging pain. He crouched. Sharkey was silent except for an occasional insane chuckle that rattled in his throat.

A Fight to the Death

CAPTAIN Wollack wanted to make certain that when he fired his Atherton at Sharkey, the explosive missile would take effect. Should he miss, and the pellet imbed itself in the wall of the cabin, there was a chance that the explosion might in some way ignite the reserve fuel in the next compartment and blow the ship to fragments.

He held his fire until such a time as Sharkey should expose himself. The outlaw lay on the floor, playing a game of waiting. But Captain Wollack desired immediate action and, with the suddenness that was characteristic of the man in action, darted his head and pistol around the chair. Apparently without aim he pressed the trigger; to his utmost astonishment the hammer clicked as it fell on an empty cylinder! Sharkey cackled and brought up his automatic. The second slug whined past the Captain's head and smashed an instrument. With a snap of his wrist the official a second time brought up the Atherton and pulled the trigger. With a curse he crouched and examined the gun. It had contained but two shells, both of which he had already fired!

He looked around for the other Atherton pistol. Just beyond his reach it lay in a pool of vermillion liquid. To get at it he must expose himself to the outlaw's fire, and he hesitated before making the move. Abruptly he lifted the cushion of the pilot's seat, and took from beneath a kit of emergency tools. He sorted them for something with which he might reach out and draw the pistol to, without endangering himself. His eyes fell on a jointed rule, and his blood raced, then he found a spindle of steel wire. Quickly he cut a piece from the spool and attached it to the end of the rule in the shape of a hook. As he opened the joints of the rule, he heard Sharkey's body scraping on the floor as the outlaw wiggled closer.

"Don't show your head, Sharkey!" the Captain said by way of subterfuge, trying to frighten the outlaw into thinking that the Atherton still contained a few cartridges: "I'll blow it off if you do!"

Sharkey lay quiet apparently accepting the threat as genuine. Captain Wollack cautiously slid the rule with its anchoring hook toward the pistol. He held it in nervous hands and the end of it bent down and trembled; he pushed it out a trifle further. The weighted end of the rule touched the metal floor and scraped loudly. Sharkey heard it and leaped erect with a bellow of rage.

Instantly Captain Wollack hurled himself upward, arm outstretched to encircle the outlaw's frame. Sharkey reached the Atherton and with a kick sent it into a corner out of the official's reach. He swung on the Captain and then attempted to leap backward as the official's arms closed around his waist. He clung tightly to his automatic but could not bring it into play. Captain Wollack held his arms locked in a terrific embrace.

As they swayed to and fro from one end of the cabin to the other, the interior became bathed in the rare colors of the spectrum. But neither of the two noticed it; the *Tobias Wollack* passed gracefully through the Aurora and rocketed beyond its brilliant curtain!

With the strength of a mad beast, Sharkey bent his adversary over the back of the pilot's chair and raised a vicious knee. Captain Wollack lifted a leg and parried the thrust; he gave a mighty heave and they both went crashing to the floor. Sharkey attempted to bring his automatic into play, but the official held to his wrist with such a grip that the outlaw's face worked in agony.

In an ordinary fight, Captain Wollack would have been no match for the insane outlaw. But forced against the wall as he now was, the official fought like a jungle cat. Holding Sharkey's wrist with his left hand, he clawed and gouged at the madman's eye with his right. The outlaw's face was torn; there was a livid gash running downward from his left eye to his lower lip. From it flowed a thin stream of red.

Sharkey sent blow after blow into his adversary's grim, determined features, but failed to remove the tight-lipped grin that held the Captain's mouth rigid.

Presently, the official jerked himself loose from the outlaw's embrace and grabbed Sharkey's right wrist again. As he jerked away and felt his hand take a firm grip on his antagonist's wrist, he swung his back around. With a sudden swing of his right arm, he brought it over and under Sharkey's right, using it as a lever-block. He pressed down on the outlaw's arm. Sharkey screamed as his elbow snapped and his automatic dropped from paralyzed fingers.

Despite his broken and shattered arm, the outlaw rushed again. Captain Wollack stepped aside and delivered a blow behind Sharkey's ear as he went by. The outlaw was sent sprawling. Without waiting for him to rise, the Captain leaped after him and clutched at his throat, his brain crying out with the lust to kill. His fingers tightened on the foe's throat, gradually tightening.

For seemingly long minutes, Sharkey struggled under the iron grip that clutched his throat and was slowly, but surely throttling out his life. Try as he might he could not break it. The Captain's fingers sank deeper, nails ripping the flesh. Before his eyes floated a curtain of red. Through it he could see nothing more than the lifeless body of the outlaw. He shook the man's head savagely and cast it aside, limp. Sharkey writhed spasmodically once or twice and then lay still.

Quickly Captain Wollack picked up the second Atherton and looked to its cylinder; it was loaded, every chamber filled. As an extra precaution he picked up Sharkey's automatic and thrust it into a pocket. He glanced out of the window; the *Tobias Wollack* had passed beyond the brilliancy of the Aurora and was heading back into it in a wide circle.

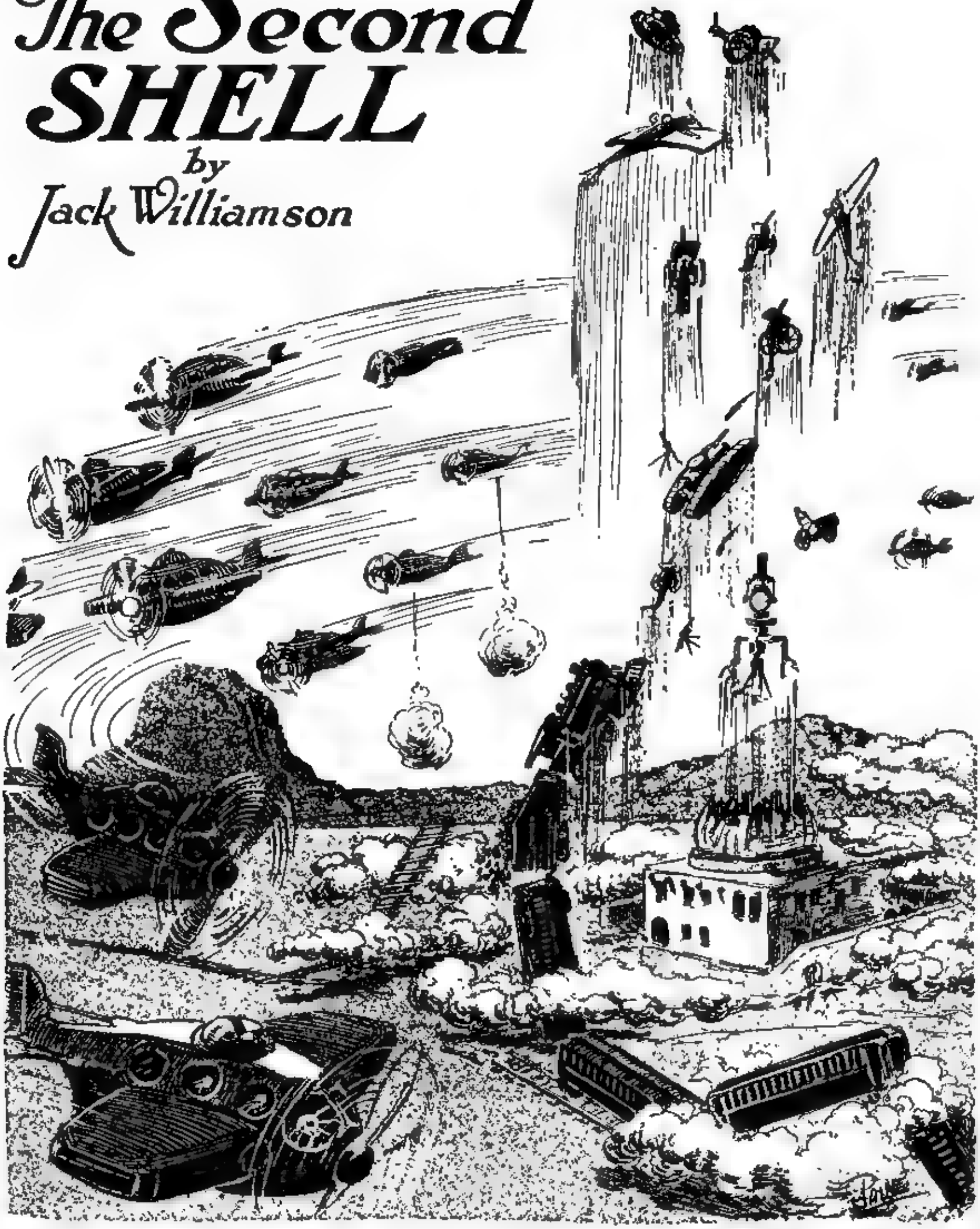
Cautiously he picked his way toward the tail of the ship. He peered around a corner before exposing himself in the companionway; it was deserted and he almost ran toward the central cabin housing the driving apparatus. He heard the sound of voices coming from the scientist's station. Making his way to the cabin swiftly, he stepped in.

(*Continued on Page 460*)

The Second SHELL

by

Jack Williamson



But in a few minutes the vicinity of the mine was dotted with the coiling hills of purple gas. I saw railway cars and engines, guns and tanks, and even the railroad rails and the mining machinery, torn from their places and plunging into the air.

THE SECOND SHELL

By the Author of "The Alien Intelligence," "The Girl from Mars"

IT WAS two o'clock in the morning of September 5, 1939. For a year and a half I had been at work on the San Francisco *Times*. I had come there immediately after finishing my year's course at the army officers' flying school at San Antonio, on the chance that my work would lead me into enough tong wars and exciting murder mysteries to make life interesting.

The morning edition had just been "put to bed" and I was starting out of the office when the night editor called me to meet a visitor who had just come in. The stranger came forward quickly. Roughly clad in blue shirt and overalls, boots, and Stetson, he had the bronze skin, clear eyes, and smooth movements of one who has spent his life out-of-doors.

He stopped before me and held out his hand with a pleasant smile. I saw that his hair was gray; he was a little older than I had thought at first—fifty, perhaps. I liked the fellow instinctively.

"Robert Barrett?" he questioned in a pleasant drawl. I nodded.

"I'm Bill Johnson," he said briefly. "I want to see you. Secret Service business. *Sabe?*" He let me glimpse a badge; and we walked out into the night. As we started down the silent street it occurred to me that I had head of this man before.

"Are you the William Johnson who unearthed the radio station of the revolutionaries in Mexico in 1917?"

"I guess so. I've been in Mexico thirty years, and I've helped Uncle Sam out a time or two. It's a case like that one, or worse, that I'm up here to see about now. I need a partner. I've been told about you. Are you game for a little adventure?"

"You've found your man."

"They call you 'Tiger Bob Barrett,' don't they?" he said irrelevantly.

"I used to play football."

He laughed. I have always been sensible about that nickname.

"Well, here's the situation. I've been at Vernon's mine in Durango, Mexico. Called El Tigre. Gold and thorium. There's a little mystery—"

"Vernon? Is it Doc Vernon, the scientist. His daughter inherited a mine—"

"*Si, Señor.* Ellen Vernon is some young lady!"

"I knew them at Texas University. I was in Vernon's chemistry class before he went daft on his death ray machine, and left to work on that."

"The Doc is still at work on the machine. In fact, that is a part of the mystery.

JACK WILLIAMSON

"The mine is in an old corner of the desert, about fifty miles south of Mocolynatal—the big mountain. And there's something queer going on about that mountain!

"Ellen got herself a radio set to pass away the time with. She got to picking up strange stuff. Sounds we couldn't make out! Not just a strange lingo. They don't sound like the human voice at all! Strange chirps and squeaks! Doc and I rigged up a directional set, and found that the calls were sent from Mocolynatal.

"The mountain's in sight, to the north of us. I got to watching it, and found out something else. There have been airplanes flying about it—queer red machines with short stubby wings! They flew off mostly to the west. I did a little more investigation, and found that a line of run-down Jap tramp steamers has been hauling cargoes of the-lord-knows-what, and unloading somewhere along the Pacific coast of Mexico—evidently making connections with the red ma-

[redacted]

"Now, the Doc has his machine where he thinks it will be the end of the world if anybody gets hold of it. We've seen one or two of the red planes over the mine, and he is afraid they have found out about it, somehow. He got nervous, and sent me up to see Uncle Sam. It is all news to the State Department, and we are going to investigate.

"One of the Jap tramps is leaving here tomorrow, and there will be a couple of destroyers on the trail, to see what they unload, and where. I've got hold of a new airplane—a queer little machine called the Camel-back, that I'm taking along on board. A jewel for mountain work—you could land it on a handkerchief. I needed a partner, and the Doc told me about you. Want to go along?"

"You bet I do! I've been longing for something to turn up."

"Well, be at the landing field at nine tomorrow—this morning, rather, ready for anything. This may be interesting before we're through. *Buenas Noches.*"

HERE the well-known author of "The Alien Intelligence" and other thrilling stories presents his latest symphony, a fine piece of aerial fiction.

Few authors have Jack Williamson's knack to pack their stories with so much adventure and with so much imaginative science. And while it may be fantastic today, most of it we know, sooner or later, will have become reality.

All scientists for decades have been wondering what the mysterious Heaviside Layer is. Radio engineers know of the Heaviside Layer from its effect on radio waves. It is very much of a fact, yet no one has ever been able to get near it, due to its distance above the surface of the earth, and till we have penetrated it, we cannot be sure what lies above it.

We know you will enjoy the present story, which easily bears re-reading from time to time.

A Raid and a Mystery

THE old fellow left me, and I walked on toward my apartment, thinking over what I had heard. Dr. Vernon's invention a success at last! I remembered very clearly my days with the nervous, stammering little scientist, always sure that tomorrow would bring the great secret. And I thought of Ellen—indeed, I had often done so in the two years since I had heard from her. I wondered why she and her father had left Austin so suddenly,

and why their destination had been kept a secret from all their friends.

As for the matter of the red planes, I could suppose nothing but that the outs in Mexican politics were preparing a little military surprise for the ins. There have been too many military forces raised secretly in Mexico for one of them to be much of a novelty. Then I thought of the queer radio messages. They did not fit in very well. But my mind returned to Ellen again. I thought no more of the red machines. I had no thought—no one on earth had warning—of the terrible force that was rising to menace the world.

In the morning, when I came down to the lobby, I found a curious clamor going. There was a hum of conversation, and people were passing around red-paper "extras". It was five minutes before I could get one to read the screaming headlines:

RED PLANES RAID FACTORY,
THREE HUNDRED DEAD
MILLION DOLLAR STOCK OF
THORIUM TAKEN

The account went on to describe the raid, at four o'clock that morning, of a fleet of red airplanes upon the Rogers Gas Mantle Factory, at St. Louis. It was stated that three hundred people had been killed, and that the entire stock of thorium nitrate on hand, worth over a million dollars, had been carried off.

Much of a mystery was made of it. Police had failed to identify three of the four red-uniformed corpses left behind. Fingerprints identified the other as a noted criminal recently out of Leavenworth.

No one seemed to have any idea why the thorium had been taken, since the chief use of that radioactive metal, which is similar to radium, but far less active, is in the manufacture of gas mantles.

It was farther stated that the raiders had released "clouds of a luminous purple gas," which had caused most of the fatalities, and which seemed to have destroyed the gravity of metallic objects about. It was said that the factory building was curiously wrecked, as if the heavy machinery had gone up through the roof.

At first it struck me that this must be simply a newspaper canard. Then I remembered what Bill Johnson had told me of the strange red airplanes in Durango, and of the mystery of the secret radio station. Then I was not so sure. I ate a little breakfast and hurried out to the landing field. I found Bill with a copy of the paper in his hand. His wrinkled face had a look of eager concentration on it.

"Howdy, Bob," he drawled. "This looks interesting. Have you seen it?" I nodded. "It must be the same red planes. Let's get off."

We walked out on the field, where the "Camel-back" plane was waiting. It was the first one I had seen; one of the first models built, I believe. It was based on Cierva's *Autogiro*, or "windmill plane". But there was an arrangement by which the rotating mast could be drawn into the fuselage, the rotation stopped, and the vanes folded to the side, so that the machine, in the air, could be transformed into an ordinary monoplane, capable of a much higher flying speed than the *Autogiro*. When the pilot desired, a touch of a button would release the mast and vanes, and the machine became an *Autogiro*, which could spiral slowly or drop almost perpendicularly to a safe landing on a small spot of ground.

The machine had a further innovation in the shape of a Wright turbine motor. This had but a single important moving part, the shaft which bore the rotors, the flanged wheel that drew the mixture into the combustion chamber, and the propeller. Because of its extreme light weight and high efficiency, the internal combustion turbine engine now promises to come into general use.

The name of the machine, "the Camel-back," was due to the peculiar hump to the rear of the mast, covering the levers for raising and lowering the rotating "windmill."

The plane carried a .50 calibre machine gun in the forward cockpit.

"Get aboard, Bob, and we're off," Bill said as we got on our parachutes. "The tramp weighed anchor at four this morning, and the destroyers left an hour later. We'll be able to pick them up."

Five minutes later our trim little machine was rolling forward with the "windmill" spinning. It swept smoothly upward, Bill moved into gear the device that brought down the mast, and soon we were over the cold gray Pacific, with the city fading into the haze of the blue northern horizon.

Bill was flying the ship, and my thoughts turned back to Dr. Vernon and his daughter. The Doctor was a pudgy, explosive little man, who thought, ate, and breathed science. His short, restless figure always bore the marks of laboratory cataclysms, and his life had been marred by the earlier lack of success in perfecting the terrible machine to which he was devoting his life. I had always thought it strange that a man so mild and tender-hearted should toil so to build a death-dealing instrument, and I wondered what he would do with it now if he had it completed.

It was five years since I had seen Ellen. She had been but a spritely, elfin girl. I remembered her chiefly as having been instrumental, one day at a party, in getting me to drop myself into a supposed easy chair, which turned out to be a tub of ice water.

CHAPTER II

The Menace of the Mist

THE little Camel-back plane was a wonder. The soft whispering hum of the turbine engine belied its tremendous power. The slender, white metal wings cut the air at the rate of two and a half miles per minute. Presently we saw a smudge of smoke where the blue sea met the bluer sky ahead, and soon the little machine had dropped on the deck of a destroyer.

The sister vessel was four or five miles to starboard. The two ships were plowing deliberately along, at about ten knots, keeping some twenty-five miles behind the tramp steamer they were shadowing. One of the officers took us up on the little bridge, and we learned that the little ships were keeping track of the tramp with their radio equipment.

The radio man took us in and let us listen to the calls between the tramp and some point far ahead. Those were the strangest sounds I have ever heard. Thin, stuttering, stridulating squeaks and squeals! Even allowing for distortion in transmission, it was hard to imagine what might make them.

"That's something talking," Bill said. "And human beings don't make noises like that."

"It may be," the operator said, "that what we hear is just an ordinary conversation, 'scrambled' to keep us from understanding it, and 'unscrambled' by the receiver. Such devices have been in use for years."

But there was no conviction in his voice. And certainly, those strange noises sounded to me like the communication of some alien beings. But what might they be?

Later in the day, Bill and I took turns in going up with the Camel-back to keep tab on the movements of the tramp, since the radio calls had ceased. The day passed, and the white sun sank back of the glittering western waves. During the hot, moonless night, the ether was still, and we could do nothing but steam on in the same direction. I went up twice, but the tramp was showing no lights, and I failed to locate her. At midnight Bill came on deck, and I went below to a bunk.

It was just after dawn that the alarm was sounded. I was awakened by the roar of the little ship's forward gun. It was firing steadily as I went on deck, and I heard a confusion of sounds—the siren was blowing, and there was a medley of shouts, orders, and curses, punctuated with the reports of small arms.

I saw that the Camel-back was gone from the deck. Bill was up again.

As I stepped on deck there was a great clanging roar from below. The propellers had been lifted from the water! The engines raced madly for a minute, and then were stopped. I ran to the trail to see what had happened to throw the organization of the crew into such confusion. And indeed it was an amazing sight that met my eyes!

The ship was floating in the air, a hundred feet above the waves! The air was still, the sea was smooth and black . . . The eastern sky was lit by the silver curtain of the dawn, with the old moon hanging in it. Before us, and below, two hundred yards away, was a queer luminous hill—a shining cloud of red-purple vapor that rolled spread heavily upon the black water. I saw two similar twisting mounds of gas astern, gleaming with a painful radiance.

And the ship was rising into the air!

It was drifting swiftly up, through the still air, so that a wind seemed to blow down upon us. I saw a rifle hanging in the air ten feet above me, and a steel boat rising a dozen feet over the mast. Suddenly it came to me that something had negated the gravity of the metal parts of the ship. I thought of the story of the gravity-destroying bombs used in the raid of the night before upon the thorium stores.

The forward gun was still firing steadily, though the terrorized men had deserted the others. I saw a man point above us, and looked. A red airplane, with thick fuselage and short wings, was flying silently and swiftly across our bows. As it passed, something fell from it. It was a dark object that fell and exploded just above us, bursting into a thick, roily cloud of shining purple mist. The light of it hurt my eyes. And the ship plunged upward faster.

In view of what happened later, there can be no doubt that the luminous gas was a radioactive element derived by the forced acceleration of the decomposition of thorium. It was similar to the inert radioactive gas niton, or "radium emanation," which is formed by the expulsion of an alpha particle from the radium atom. And there can be no doubt that its emanations affected the magnetic elements, iron, nickel, cobalt, and oxygen in such a manner as to reverse the pull of gravity. With the invention of permalloy and other similar substances in the past decade, such a thing is much less incredible than it might have seemed ten years ago.

In a few moments the red ship had passed out of sight. Looking dazedly to the west, I saw a number of bright points of purple fire against the deep blue of the sky—radioactive clouds sending out the gravity-nullifying radiations. The dark shape of the other destroyer, upside down, was floating up among them. It must have been almost a mile up, already.

As I stood there astounded, the officers seemed to be making a furious attempt to restore order. Then men were running about, babbling and cursing in utter confusion. I saw one man don a life belt and jump insanely over the rail—to plunge like a plummet to the water five hundred yards below. A dozen more poor fellows followed him before the mate could stop the rush. And perhaps their fate is as good as that of the others.

Suddenly a wild-eyed seaman sprang at my throat. In spite of my amazement, I was able to stop him with a punch at the jaw. In a moment I realized what he was after. The parachute that I had worn on my last flight in the Camel-back was strapped to me. As the fellow got up to charge again, the deck tilted (probably the ship was upset by the recoil of the gun).

Presently I found the rip-cord and jerked it. The white silk bellowsed out behind me, while my unfortunate shipmates fell, dwindling dark specks, to make white splashes in the sea below. The ill-fated ship must have been half a mile high then. I glimpsed it once or twice, a vanishing black dot—driven out into space!

By the time I had struck the chill water I almost wished that I had fallen with the others. I contrived to cut the harness loose, and to get rid of my coat and shoes; and set myself to the task of keeping afloat as long as possible.

On to the Mine

IT must have been an hour later that I heard the hum of the Camel-back's propeller, and saw the little machine skimming low over the waves. Bill leaned out and waved a hand in greeting. In a few minutes he had brought the machine down lightly in the water beside me, and hauled me aboard.

"I went up at three o'clock," he said, "to see if I could locate the Jap. I was coming down when the red machines began to let loose their shining clouds. The plane went up. I stopped the engine, and still it went up. Its weight was gone. I almost froze before it started falling."

"Those ships may go on to the moon! They may become minor satellites themselves!"

"You saw the red machines dealing out the dope?"

"One of them. Who could it—"

"It's our job to find out. We better head back for the mine, to see what's happened there."

The trim little machine skimmed smoothly over the level sea, and easily took the air. We flew southwest.

It was not many hours before we sighted land that must have been the lower tip of Lower California. In an hour more we were flying over Mexico, the most ancient, and paradoxically, the least known country on the continent.

We flew over a broad plain checkered with the bright green of fields, over ancient cities and mean adobe villages, and over the vast forests of pine, cut with twisting canyons, that cover the slopes of the mighty mountains that rose before us. As we went on, the green valleys of the rushing mountain streams grew narrower; and the grim wild peaks that rimmed them, higher and more frequent. Sheer jagged summits rose above steep, forest-covered slopes. We were reaching the heart of the Sierra Madre range.

At last the vast bare conical mountain loomed up to the north of us, that Bill told me was Mocolynatal—the place of the hidden radio station. Its sheer black slopes tower fifteen thousand feet above the sea. From its appearance, it was not hard to guess that it had a crater of considerable dimensions.

The mountain crept around to our left, as we flew on toward the mine. Suddenly Bill shouted and pointed toward the peak. I looked. Above the dark outline of the cone, a huge globe of blue light was rising, flaming with an intense brilliance that gave a ghastly tint of blue to all that desert wilderness of peaks! Like a great moon of blue fire, it rose swiftly into the sky! It dwindled, faded, was gone!

I felt the hair rise on my neck. I was glad that our plane was swift and far away. If it was a human power with which we had to deal, I thought, it must have made strange advances. And then I remembered the strange noises upon the ether—sounds more like the stridulations of great insects than the voices of men!

"That has happened twice before," Bill said. "But I didn't tell anybody about it in the States. It's too damned unbelievable."

At the Thorium Mine

IN half an hour we were fifty miles south of Mocolynatal, circling over the mine. El Tigre Mine is near the center of a rocky, triangular plateau. Northwest and southwest, the Sierra Madre rises. On the east side of the triangle is the river, a tributary of the Nazas, in a canyon deep enough to hold the stream a hundred times. Perhaps a dozen square miles are so enclosed. It is a desert of sand and rocks, cut up with dry arroyos, scantily covered with yucca, mesquite, and cactus.

The mine buildings stand on the little stream that cuts a track of vivid green across the neutral gray of the waste to the canyon below. Sitting there on the dull-hued plain, with the Cordillerras rising so abruptly a few miles back, the buildings looked very tiny and insignificant. Across the stream from the shaft-house, the shops, and the quarters of the men is a square, fortress-like two story residence of rough gray stone . . . The narrow-gauge railroad track runs from it down toward the canyon like thin black threads.

As we flew over the buildings, a trim white figure appeared on the roof of the residence, and waved a slender arm. I knew that it must be Ellen, and I felt oddly excited at the thought of seeing her again.

Bill touched the button that released the rotor, and the machine settled lightly to earth near the main building. A short waddling person and a slender active one—the Doctor and Ellen—came out of the house and hurried toward us.

"Why h-h-h-h-hello, Bob, I'm s-sur-surprised to see you," the Doctor rattled off. I have always had the opinion that he wouldn't stammer if he would take time to talk, but he is always in a hurry. "You're w-w-w-welcome, though. Looks like a new m-ma-ma-machine you have, Bill. The red ship c-c-c-came again while you were gone. I've got something to t-t-t-t-tell you. But get out and come in to the shade."

He hurried us toward the house. He was just as I remembered him—a short man, a little stout, with a perpetual grin on his moon-face, and movements as short and jerky as his speech. He was panting with excitement, and very glad to see us.

Ellen Vernon was, if possible, even more beautiful than she had been to my boyish eyes. Her dark eyes still held the flame of restless mischief that had brought me the icy plunge. I believe a recollection of the incident passed through her mind as she saw me, for her eyes suddenly met mine engagingly, and then were briefly turned away, while a quick soft flush spread over her glowing, sun-colored cheek. I got a subtle intoxication even out of watching the smooth grace of her movements.

We shook hands with the Doctor, and Ellen offered me her strong cool hand.

"I'm glad to see you, Bob," she said simply. "I've often thought of you. And you've come in at an interesting time. Dad turned loose his ray yesterday, and brought down one of the red machines. I guess Bill has told you—"

"Yes," the Doctor interrupted, "the th-th-th-thing had come sneaking around here once too often. I tried the tube on it and it fell about a mile up the creek. Funny thing about it. The red ship struck the ground, and then something left it and went b-b-b-back into the air!"

"Something like a bright blue balloon carried the thing up in the air," Ellen added. "It saved itself with that, just like a man wrecked in the air uses a parachute. But it was not a man that sailed up under that ball of blue light! It was a queer twisting purple thing! I used the field glasses—"

"It's not m-m-m-men that fly the red ships," the Doctor said. "It's c-cre-cre-creatures of the upper air!"

We stepped up on the broad, shady verandah, and Bill and the Doctor stopped by the steps, comparing notes. Ellen gave me a welcome drink of icy water from the wind-cooled earthen *olla* hanging from the roof. Straight, and tanned, she looked very beautiful against the desert background. She was the same girl she had always been—bright, daring, and alluring. Neither she nor the Doctor seemed unduly excited over the astounding news they had just delivered.

The desert lay away to the eastward, undulating in the heat like a windswept lake. Gray or dully green with the yucca and manzanita upon it, it was sharply cut by the rich green mark of the wandering stream. Its vastness tired the eyes, like a limitless weird dead sea. North and south the mountains rose, gripping the plain in a grim and ancient grasp. The hills were still tinted with the blues and purples of the morning shades, save where some higher peak caught the sunlight and reflected it in a fiercer, redder gleam. Far in the north, above the nearer peaks, I made out the

distantly mysterious, dull blue outline of Mocolynatal—the mountain of the hidden menace.

In such a wild and primitive setting, human civilization seemed a distant, unimportant issue. The menace of the desert, of naked nature, alone seemed real. No wild tale was incredible there.

And the wonderful girl before me, smiling, cool and resourceful, seemed to fit in with that rough scenery, seemed almost a part of it. Ellen was the kind of woman who can master her environment.

"Coming down here was a pretty severe change for a campus queen, wasn't it?" I asked her.

"The royal blood never flowed too freely in my veins," she said. "I rather like it here. The ore train from Durango brings the mail twice a week, and I read a lot. Then, I'm beginning to love the desert and the mountains. Sometimes I feel almost like worshipping old Mocolynatal. They say the Indians did."

"I wonder if it's ever been climbed?"

"I think not. Unless by the owners of the red airplanes. Dad thinks they are things that have come down out of the upper air to attack the earth. I've always been sorry I wasn't here when the tiger was killed, but this promises a bigger adventure yet! And I'll be right in the middle of it!" She laughed.

The Death Ray

"I HADN'T heard of the tiger's misfortune," I said, a little amused at her eagerness for adventure.

"You know Uncle Jake had a ranch down on the Nazas. Once he trailed a tiger up here with his hounds. He killed him right here, and happened to see the glitter of gold in the blood-stained quartz. He named the mine El Tigre—The Tiger. Along with the gold ore are deposits of *monazite*—thorium ore. Dad began to work them when we came to get thorium to use in his experiments."

"Say, Bob," the Doctor called, "I want to sh-ah-ah-show you something. Come on in the lab." The little man took my arm and hurried me down the long cool hall, and up a flight of steps to a great room on the second floor. It suggested an astronomical observatory; it was circular, and the roof was a great glass dome. In the center and projecting through the dome was a huge device that resembled a telescope. About the walls a variety of scientific equipment.

"That's my r-r-r-ray machine," he said. "Modified adaptation of the old Coolidge tube, with an electrode of molten *Vernonite*. *Vernonite* is my invention—an alloy of thorium with some of the alkaline earth metals. When the alloy is melted there is a comparatively rapid atomic disintegration of the radioactive thorium, and the radiation is modified by passages through a powerful magnetic field, and by polarization with quartz prisms. The Vernon Ray has characteristics controllable by the adjustment of the apparatus, generally resembling those of the ultra-violet or actinic rays of sunlight, but intensified to an extreme degree.

"The chemical effects are marvelous. The Vernon Ray will bleach indigo, or the green of plant leaves. It stimulates oxidation, and has a tendency to break up the proteins and other complex molecules

"This tube has a range of five miles, and will penetrate a foot of lead. I have killed animals with it by breaking up the haemoglobin in the blood. By special adjustment, its effects would be fatal at even greater range. It might be set to break the body proteins into the split protein poisons—there are a thousand ways it might kill a man, quickly or by hideous lingering death.

"Used in war, the Vernon Ray would not only kill men, but destroy or ignite such useful chemicals as fuels and explosives. It would destroy vegetation and food supplies. In fact, it would make war impossible, and it is my hope that it will end war altogether!"

"But what if the wrong fellow gets hold of it?"

He nodded to a safe at the wall. "Plans locked up there. And nobody knows about it. Even if someone had the plans, he could hardly secure the large quantities of thorium required without attracting attention." I thought of the raid on the gas mantle factory.

"I mean to turn it over to the American government pretty soon, but I hope to make another development. Ordinary heat and light waves set up molecular disturbances in matter; in fact, heat is merely molecular vibration. I hope to discover a frequency in the spectrum that will stimulate atomic vibration to such an extent as to break down the electronic system. Objects upon which such a ray is directed will explode with incredible violence. In my earlier experiments with *Vernonite*, the molten alloy in the tube, I almost had a catastrophe from the atomic explosion of the electrode. It would have blown El Tigre off the map! The radioactivity of thorium is slight; I must increase it vastly. The adjustment is delicate."

He let me look into the apparatus. It was plainly electrical. There were motors, generators, coils, transformers, mirrors and lenses in a lead housing, vast condensers, and a huge vacuum tube which seemed to have a little crucible of glowing liquid for the anode. Back of it was a great parabolic reflector which must have sent out the beam of destruction.

"The idea of atomic force as a d-d-d-d-destructive agency is not new," he went on, again almost too enthusiastic to talk. "The sun is thought to ob-ob-ob-obtain its boundless energy from the process of atomic disintegration, and m-m-m-m-m-men of science long since agree that any instrument using intra-atomic energy would be a t-t-t-t-terrible weapon!"

CHAPTER III

Clouds of Doom

SUDDENLY a red shape flashed over the great glass dome above us. In a moment I heard Bill call out, "Hey, Doc, comp'ny's come!"

Dr. Vernon and I hurried out of the room. He paused to double lock the door behind him, and we down to the hall. We found Bill and Ellen both waiting at the front door, each holding a 30-30 carbine.

"There's one of the red ships out there!" the girl cried. Eager and flushed with excitement, she was very beautiful.

The Doctor unbuttoned his shirt and pulled out a slender tube of glass. It had a bulb at one end, with a metal shield behind it, and a pistol grip and trigger at the other. He examined it critically and turned a little dial. The tube lit up with a soft, beautiful scarlet glow. He pointed it at a vase of wild flowers, that Ellen must have gathered, on a side table. Their brilliant colors faded until leaf and petal were white.

"P-p-p-p-pocket edition of the Vernon Ray machine," he said.

He slipped it out of sight in his pocket, and Bill

swung open the door. A strange red airplane was stopped twenty yards away. The fuselage was a thick, tapering, closed compartment, with dark circular windows. The wings were curiously short and thick, as if they were somehow folded up, and I thought the propeller very large.

An oval door in the side swung out, and a little, weazened man sprang out on the ground. An astounding person! He wore a uniform of brilliant red, decorated with a few miles of gold braid and several pounds of glittering medals. He had leathery black skin, sleek black hair, and furtively darting black eyes. A deep, livid red scar across his forehead and cheek gave his face a queer demoniac twist that was accented by his short black moustache.

"Vars! Herman Vars! After us again!" the Doctor muttered in evident amazement.

The dark little man walked briskly up to the door, and saluted the Doctor, with his medals rattling. "Good morning, Dr. Vernon," he said in a queer dry voice. "I trust that you are well—you and your beautiful daughter. I need not ask how work is progressing on your remarkable invention, for I know that it is completed," he laughed, or rather cackled, insanely. "Yes, Doctor, you have given the world a great weapon, one that it will never forget!"

He was laughing oddly again when the Doctor asked gruffly, "What do you want?"

"Why, a friend of yours and mine, who has been of service to us both, informs me that you have in this building quite a large supply of the rare radioactive metal, thorium, of which I think I have a greater need than you—"

"What? You mean Pablo—" Dr. Vernon cried, his face turning white.

"Pablo Ysan, your servant. Exactly. But I must have the thorium. I need a huge quantity. I am coming for it tomorrow. You need fear nothing for yourself or your daughter—I came to warn you so that you might feel no alarm. In fact, it would flatter me to have you as my guests. But remember that I am coming—in force!"

"You damn lu-lu-lu-lunatic!" the Doctor choked.

"No. Not a madman, begging your pardon. The future king of the world! Of two worlds, to be exact! But I must leave you. Remember! And *hasta luego,* as our friend Pablo would say."

Laughing strangely again, the little man hurried back and got in the machine. It left the ground at once, with the great propellers whirling slowly. The motors were oddly silent. I thought the red wings were somehow unfolded, or lengthened out a little.

As it rose, I glimpsed the pilot of the machine.

It was not a man!

It was a queer, gleaming purple shape, with many tentacles!

With strange horror grasping at my heart, I looked quickly at the others, but it seemed that they had not seen it. Then I remembered the Doctor's words of "creatures of the upper air" and I thought of what Ellen had said of the thing that had risen from the wrecked ship.

"That was Herman Vars," Ellen whispered to me. "We met him at the University. He had a warped mind—tinkered with radio and claimed he was getting in touch with beings of a plane above the earth. Then —once—" she paused, flushing a little,"—well, he came to me and told me that he was going to conquer the earth, and that he wanted me to—to go with him. That was why we left Austin. I thought he was only insane—but this!"

"And he must have been t-t-t-t-telling the t-t-t-t-truth!" the Doctor said. "And he is coming after my thorium! I wonder—Pablo—the blueprints—" Suddenly he left us and ran down the hall.

"Pablo Ysan was a Mexican who helped him sometimes in his experiments," Ellen told me. "He went away a month ago. He must have carried Dad's plans to Vars."

The Doctor came back with a grim look on his face. "They're g-g-g-g-gone!" he said. "That's why they want thorium. And I've got enough here to wipe out the earth, if they can use it—if they can use it," and a grim half-smile flickered over his face.

"I'll run down to Durango on the rail car," Bill said. "I can have a train load of troops up here by night. Mendoza is one of my *amigos*—once I did him a good turn—" The Doctor nodded. "And if anything happens while I'm gone, you have your ray, and Bob can take up the Camel-back."

The Battle

HE WENT out. In a few minutes I heard the sputter of a gasoline engine, and the ringing of the little car's wheels on the rails, as it sped down the narrow track. The machine dwindled to a black speck on the desert's rim, and dropped out of sight.

Dr. Vernon spent the evening tinkering with his tube. I went over with Ellen, to look at the mine. The men had been frightened by the red ships, a few days before, and had left on the train. The place was deserted. We peered down the silent black shaft, and went back. But most of the time I spent watching the sky for a sight of the red planes, ready to warn the Doctor and to go up to meet them.

Four trains pulled in before midnight, carrying one of those mobile military units with which the Montoya government so effectively nipped in the bud the revolutionary movements of 1933 and 1935. There was a battery of eight French seventy-fives and a heavier railway gun, four light tanks, a dozen battle planes and two bombing planes, and about four hundred infantry.

Before dawn, El Tigre looked like a military encampment. In the glare of great searchlights, men were digging trenches, leveling a landing field for the planes, and planting the battery. The Doctor had his ray machine ready for use.

I was much surprised at the discipline and efficiency of the well-trained Mexican troops.

With the rising of the sun, a sentry's hail proclaimed the appearance of a score of dark specks above the grim outline of Mocolynatal—a fleet of red planes, coming to the attack!

In a moment the camp was alive. The gun crews got to their posts, airplane engines were started, infantry were lined up in the freshly dug trenches, with machine guns and rifles ready. I saw the gleaming tip of the Doctor's great tube projecting above the huge glass dome.

In a few minutes the planes were taking the air, flying to meet the coming ships. I was with them, in the Camel-back.

I had often dreamed of the thrills of war in the air, and I was eager enough for the encounter. But, as it turned out, I was to play no noble part.

The red machines flew toward us with astonishing speed. In a few minutes they were upon us. Because of the greater speed of my ship, I was flying a little ahead of the formation of Mexican planes. That circumstance probably saved my life, as things turned out.

I was firing a burst to warm up my gun when there was a puff of smoke from the foremost machine of the red ships. I watched the tiny black projectile that came toward us, saw it pass far below me and burst into a thick cloud of gleaming purple vapor that rolled and coiled like a strange creature of the air.

And the wings of my machine no longer caught the air! The controls were useless. I was drifting up. The radiation of that shining cloud had negated the gravity of the machine!

Half a dozen more of the strange bombs burst behind me, and I saw the other ships drifting up, even more rapidly than mine, for they had been nearer the clouds. I kept firing for a minute, but I believe I hit none of the red ships. Soon they had passed beneath, in the direction of the mine.

Helpless, I drifted on into the sky!

I had a clear view of the battle at the mine. As the red machines came within range, the railway gun and the camouflaged seventy-fives began firing. One of the red ships suddenly went down in flames, and then two more. Whether they were hit, or were victims of the Vernon Ray, I do not know.

But in a few minutes the vicinity of the mine was dotted with the coiling hills of purple gas from the gravity-destroying bombs. I saw railway cars and engines, guns and tanks, and even the railroad rails and the mining machinery, torn from their places and plunging into the air. Suddenly the huge glass dome was shattered, and a great object shot up through it—Dr. Vernon's terrible instrument!

What can men do against instruments that hurl them off the earth?

By that time I was so high that the whole plain about the mine was but a tiny brownish patch, and soon that was veiled in the mists of distance. I grew very cold, and beat my arms against my sides to warm them. My breath grew short, and presently my nose began to bleed. The blue sky grew darker until a few stars broke into view, and then many. The flaming sun seemed to give no heat. Intense cold crept over my limbs.

As I was floating upward to my doom, I thought of the impending fate of the earth. The red fleets might sweep over the world, sending armies, battleships, cities and factories into the frozen night of space. That madman, Vars, with his incredible allies that we had glimpsed, with the negative gravity bombs and Dr. Vernon's ray machine, could realize his mad dream of world dominion. Humanity would be helpless against his insane power.

Amid those speculations of the horror to come, my consciousness faded.

The Camp in the Crater

THE next I knew, it was late in the evening. The sun was low over the black hills in the west. My machine was still perhaps two miles high, and floating slowly down. I started the motor, and got the machine under control.

I found that I had drifted far to the east of the mine. By the time the red sun set, I was back over it. I landed in a terrible scene of wreckage. All objects of iron—machines and weapons—were gone. Trenches, shelters, and buildings were stripped ruins. Here and there were dead men, singly and in piles. They showed no wounds; either they had been killed by the intense radioactivity of the gravity bombs, or by a Vernon Ray machine carried on the red planes.

I landed by the ruined residence, near two dead men in uniform. In fearful anticipation, I hurried through the silent rooms. The doors were broken down and the walls were bullet-splintered—there had been fighting in the hall. I searched the empty rooms in which the precious thorium had been stored. Three more cold bodies I found, but they were of the Mexican soldiery. I found no trace of Ellen, Bill, or the Doctor.

Had they been swept away into space? Or had the triumphant lunatic, Vars, taken them captive and carried them to his stronghold in the crater of Mocolynatal?

I did not find the Doctor, but in his laboratory, in the inside pocket of a coat carelessly thrown aside, I found the compact little ray tube with which he had bleached the flowers on the day before. I examined it curiously, and put it in my pocket.

Darkness had fallen when I went out to the Camelback, got in, and started the turbine motor. I rose into the night and flew northward over the starlit mountain wilderness. At last I made out the shape of Mocolynatal ahead, and climbed far above it. I sailed over, and came upon a strange scene.

Indeed, the mountain had a crater! Below me was a great bowl, perhaps two miles across, brilliantly lit by rows of electric lights. I made out long lines of buildings—huge structures of sheet iron, gleaming in the light. Toward the south rim seemed to be a landing field, with broad beams of intense light pouring out over the hundreds of red planes lined up across it. North of that was a lake, and I saw scores of red seaplanes moored by brightly lit docks at the edge.

There was movement below me. I saw the headlights of moving trucks upon smooth gravel roads about the lake, and there were men at work on the docks and at the landing field. Dense smoke, a luminous white in the glare of the lights, was rising from some of the buildings that must have been factories.

The lunatic had indeed made thorough preparation for his planned attack against the world!

I cut off the engine of my machine, set the motor to whirling, and dropped silently toward the circle of darkness about the rim of the crater. In fifteen minutes more I had landed it on a bare, rocky slope. I waited a moment, but there was no sign that my coming had been observed, so presently I left the plane, with my automatic in my hand, wishing I knew how to operate the strange weapon in my pocket.

I spent several hours slipping about in the shadows among the fallen boulders on the bank of talus about the rim, looking down into the brightly lit crater. At last, I came down in the shadow of an isolated building of gray concrete, with slender masts rising above it—the hidden radio station.

In an open space before it, flooded with light, I saw a strange machine. It was like one of the red airplanes, but the closed fuselage was so large that it looked almost like a small dirigible balloon, while the short wings were no larger than those of the ordinary machines. It occurred to me that the "negative-gravity" gas was probably used to lift it.

As I stood watching it, I saw a party coming aboard. There were a dozen soldiers, in red uniform. Among them I recognized the short figure of Vars, the maniac, if he was a maniac. And behind him were three closely guarded figures, one of them evidently a woman. Were they my three lost friends? I had every reason to think they were. Vars had promised not to injure Ellen or the Doctor, had implied that he wished to take them with him.

I was still watching when I heard a light footstep behind me. I whirled quickly, only to receive the sharp point of a bayonet against my chest.

"Drop it!" a sharp voice commanded as I tried to raise my automatic. The pressure back of the keen blade was somewhat increased, and I obeyed.

"Where did you come from, anyway?" the voice inquired.

I said nothing.

"Then I'll give you a chance to tell somebody else, Pard."

A dark-faced man in red uniform stepped out of the shadow of the building. He searched me, and discovered the Doctor's little weapon. "What's this, Pard?" he asked quickly.

Desperately I cudgeled my brain. "It's—er—a patent radium cigarette lighter. Inventor gave it to me. I broke it the other day."

He looked at me sharply. I tried to assume indifference; and he handed it back. "Forward march, and no tricks," he ordered, and prodded me with the bayonet until I would have given a good deal to know the secret of the little weapon he had returned to me.

Presently we reached a low concrete building. He put me past a barred door, and locked it. I was left alone in the dark. Presently I struck the few matches I had, to examine the little weapon. I set the dial by guess, and found the tiny lever that lit the tube with the soft crimson light, but I could not test it.

Toward morning I had an incredible visitor!

A pale violet light was suddenly thrown through the bars of the door. I looked up to see the amazing Thing before it, regarding me. It was octopus-like, with a central body upheld on a dozen whip-like tentacles! But it was luminous, purple, semi-transparent!

The shapeless glowing purple body had a nucleus of red—a little sphere of intense red light embedded in the shining form. It seemed like a terrible eye, watching me.

For a moment the awful thing was there, and then it moved silently away, drawing itself upon the slender gleaming tentacles. It left me weak and trembling. I hardly dared believe my eyes. Was this one of the "beings from another plane" with which Vars had allied himself in his insane attack against the earth?

CHAPTER IV

The City Above the Air

AT LAST the light of day, filtering through my prison bars, aroused me from a terrible dream of a gleaming purple octopus that was crushing and strangling me in its coils. Little did I realize how soon that dream was to become a reality!

The red-uniformed sentry came and brought me a little breakfast. I tried to engage him in conversation as I ate, but all I could get out of him was "Aw, shut your trap, Pard!"

He ordered me out of the cell. As I stood outside, blinking in the blaze of morning sunshine, I saw that the crater had been deserted since I had entered. The rows of great sheds were empty, with doors ajar. The long lines of red planes were gone. Even the great ship into which I thought Ellen and the others taken was not to be seen. The radio station appeared to have been dismantled. There were no more than a dozen airplanes left in the pit; and even as I looked, some of these took off and spiraled up into the sky.

Had the maniac finished his preparations for an attack upon the earth? Had his dreadful army gone forth to begin the ruin of the world?

The guard motioned with his bayonet toward one of the red ships near us on the ground. "Hustle!" he said. "Get aboard. You are going up to see the Master."

From what I later learned, there must have been several hundred white men in the conspiracy with Vars. In exchange for their services, he had offered freedom from the law (which was a great inducement to the class of men he gathered) and a chance to share in the spoils of world conquest. His recruits had numbered bandits and desperadoes of all descriptions, and even a few unscrupulous men of finely trained minds.

In a few minutes we were in the fuselage compartment of the red machine. It was closed and made air-tight. We were seated upon comfortable chairs, and had a good view through circular windows in the sides. The pilot was forward, out of sight, and there was another closed space to the rear, but our compartment took up most of the hull.

The guard refused to answer my questions concerning the ship's propulsion, but I later learned that it was lifted by the negative gravity gas. The motors utilized intra-atomic energy derived by the forced decomposition of thorium, and at high altitudes the propellers were supplemented by rocket guns.

Besides my taciturn guard, there were two other men in the ship. One, a fat, red-faced fellow, who looked as if he had been drinking too much *mescale*, was boasting of his close association with Vars, "the Master," and of his promised part in the spoil of the earth conquest.

The other was a lean, shrunken man, with red eyes. He stared apprehensively at the pilot's room forward, muttering to himself. I caught a few of his words,

"The shining horrors! The shining horrors. Devils from the sky!"

The machine left the crater floor and flew rapidly up on a steep spiral course. In a few minutes the rugged mountain panorama was spread out like a relief map below us. Presently the stars were visible, and still we climbed, comfortable enough in the heated, air-tight compartment. The propellers had been stopped, but the gravity-neutralizing gas continued to lift the vessel straight up.

Then I noticed a faint purple veil coming over the stars above. Suddenly it seemed that we were plunging through a bank of thin purple mist. Abruptly we shot above a landscape weirder than the wildest dream!

We had climbed above a vast plain!

A flat purple desert stretched illimitably away below us. Far in the west rose a colossal range of sheer purple mountains. The weird plain was covered with strange and stunted violet plants. In the south was a patch of blazing blue that looked like a lake of heavy mist. Beyond rose a forest of fern-like violet plants.

It was a new land above the air!

The sky was utterly black, above that desolate pur-

ple world. The stars were blazing with strange splendor, like a mist of sunlit diamond dust. They were brighter than they ever are on earth, for we were above the atmosphere. I turned toward the east, to look at the morning sun. Its light was blinding. The solar corona spread out like great wings from a sphere of livid white.

And on the purple desert, below the blazing sun, was a city!

Great spires and towers and domes rose above the dull flat expanse of purple and blue and violet. The strange buildings were scarlet. They gleamed with a metallic luster, as if they were made of the same metal as the red airplanes.

This was the land of the madman's allies, the home of the purple, gleaming creatures!

In all that strange world, save for the intense red of the weird city, there was no bright color. The smooth plains, the towering mountains, the great lakes, were dull purple or blue or violet. And all were semi-transparent! I could see the Sierra Madre like a little gray ridge, scores of miles below. And in the west, below those purple mountains, was the broad blue Pacific, gleaming like steel.

I cried out in wonder to the guard.

"Huh," he muttered. "It's nothin'. I've been up here a dozen times. Nothin' solid. Just mist. Even the—Things—cut like butter."

The Second Shell

CERTAINLY our machine had risen easily enough through the purple rocks below us. The scientific aspects of that second crust about the earth have been considered very carefully, and the best scientific opinions have been sought.

Mankind dwells upon a comparatively thin crust about the molten or plastic interior of the earth. It would seem there is a similar crust about the air. Science long ago had evidence of it in the reflection of radio waves by the so-called Heaviside Layer.

The volume of the gases in the atmosphere depends upon temperature and pressure. As one leaves the surface of the earth, the air grows thinner, because the pressure is less. But interplanetary space is nearly at absolute zero, where molecular motion ceases. It follows that the molecular motion of the outside of the atmosphere is not sufficient to keep it in the gaseous state at all.

The top of the air is literally frozen into a solid layer!

Scientists suspected as much when they suggested that the Heaviside Layer effect was caused by the reflection of Hertzian waves by solid particles of frozen nitrogen in the air. But it seems that the many frozen gases (for the air contains hydrogen, helium, krypton, neon, xenon, and carbon dioxide, as well as nitrogen, oxygen, and carrying quantities of water vapor) possess chemical characteristics lacking at ordinary temperatures. They seem to have formed a relatively substantial crust, and to have formed an entirely new series of chemical compounds, to make life possible upon that crust. (The rare gases of the air are monatomic, and consequently inert, at ordinary temperatures.)

It would appear that intelligence had been growing up upon that transparent and unsuspected world above, through all the ages that man had been fighting for survival below. Vars had been the first to suspect it. He had got into radio communication with the denizens of that second crust, had enlisted their aid in a war upon his fellow men!

We flew on toward the crimson city.

"The armies from there will conquer the world. Those purple things fight like demons," the fat man boasted complacently, waving his half-empty flask toward the gleaming crimson battlements.

"Demons! Yes. Devils! Hell in the sky!" the shrunken man whispered through chattering teeth, never taking his red eyes from the door to the pilot's cabin.

We were over that strange city of red metal. It was a mile across, circular, with a metal pavement and a wall of red metal about the edge. Scattered along the rim were a dozen great gleaming domes of purple.

"Gas in the domes supports the city," my guard said briefly. "The ground is mist. Won't hold up anything solid."

I suppose that a dollar would have fallen through those purple rocks as a similar disc of neutronic substance, weighing eight thousand tons to the cubic inch, would fall through the crust of our own earth. Strength and weight are relative terms. The strange crust must have seemed solid enough to the weird beings that trod upon it, until they acquired the use of metals and of the negative gravity gas. (Their "mines" may have been the meteorites of space.)

In the center of the city was a huge transparent dome, with a slender tube projecting through it. I was struck at once with the semblance of it to Dr. Vernon's ray tube. Had a duplicate already been installed here?

The fat man answered my question. "Old Vernon is some prize fool. We have his weapon as well as those already possessed by the Things. A ray tube in that city, and one in every plane. The Master has promised me a little model, to carry in my pocket. He is going to give me Italy and—"

Poison in Their Blood

I LISTENED no more, for we were dropping swiftly to a broad platform of the red metal. Upon it were long lines of the thick-bodied red airplanes. And at one side was the larger ship into which I had seen three prisoners taken.

"—the army, ready to start," I heard the red-faced man again. "I'll be over New York tomorrow." He raised his bottle unsteadily.

Our machine was dropped lightly to the top of the great ship. Two red-clad mechanics moved through our compartment, toward the rear. In the next little room we found them waiting, when my guard had made me follow. They held a round metal door, above a dark opening in the floor. It seems that the machines were placed with openings opposite, and were clamped together to prevent loss of air.

"Crawl through. *Pronto!*" said the guard, giving me another prod with his bayonet and pointing to the hole.

I put my hands on the edge of the opening, dropped through, and found myself in a dark chamber—for a second, alone. It was the opportunity I had been awaiting. I slipped out the little tube of the Doctor's. On the night before, I had set the little dial. Now I pushed over the little lever that lit the tube, and played the invisible beam through the opening.

(*Continued on Page* 461)

The Crystal Ray

From the bow of one of America's ships a beam of bluish light stabbed out and struck an enemy craft. It passed thru the vessel as tho it had been made of glass instead of thousands of tons of steel.

THE CRYSTAL RAY

By the Author of "The Space Dwellers"

A MID-AFTERNOON sun of the stirring war year 2141 A.D. shone upon a small battle flier which was speeding southward at an altitude of fifteen miles. It was a two-seated outfit, cigar-shaped and made of an aluminum alloy. On the shining metal of its body were painted several red, white and blue stars—the insignia of the United States; mounted on its prow were two dangerous looking automatic guns. Beneath the body of the machine was a convex, hollow sheet of metal containing a substance which neutralized gravity when acted upon by the electromagnetic waves sent out by the power stations throughout the western hemisphere; this device, the Whitley gravitational screen, supported the craft in the air. Hissing jets of gas ejected at the stern were driving the machine through the thin atmosphere at a velocity of nearly a thousand miles an hour. A faint wake of bluish vapor trailed behind like the tail of a comet.

In the flier were two men wearing the oxygen masks and metal armor necessary at extreme altitudes; attired in this fantastic garb they looked for all the world like a pair of goblins from some distant planet.

As members of the U. S. Scout Squadron Number Five, both had done their bit in the seemingly hopeless battle of Caucasian nations against the yellow men of Asia. Holding the controls was George Calhoun, the ace who had to his credit more than sixty aerial victories, including the bombing of two great battleships of the skies. Joseph Pelton, his companion, who in peace time had devoted all his spare moments to science, was not so successful a fighter; but he had participated in many hazardous struggles.

These men were now on a three days' leave of absence. The United States—the only formidable power of the Occident that had so far escaped being wiped out by the air fleets of Asia, could ill spare either; but science had not yet found a way to relieve the fatigue that comes with constant war.

Above them the aviators could see the deep blue-black sky, sprinkled with stars because of the rarity of the atmosphere. Beneath rolled an ever-changing panorama of earth, seemingly turned up at the edges like an enormous saucer. Now they were over the Gulf of Mexico veiled in its gray-blue mist; now above the verdant agricultural districts of Central America, long ago occupied by the invaders.

A little more than three hours after they had set out from Chicago, the young men hung over the snow-capped pinnacles of the Andes, which looked like mere ash heaps far beneath. Here was one of the few spots on earth that did not yet resound with the din of war; it was such a place they sought.

Presently the airboat began to descend in a long spiral; a few minutes later it settled gently at the edge of a little adobe village on the eastern slope of the mountains.

RAYMOND GALLUN

THE greatest advances in science will come during the next hundred years, when our understanding of the different forms of rays emitted by various strange materials is better developed. The past century witnessed the discovery of X-rays, as well as the emanation rays of radium and others. Only very recently a new ray, the cosmic ray, has been announced as a very potent factor in our lives. That many more materials found to emit powerful rays will be discovered, some of them with deadly and altogether unexpected qualities, is a foregone conclusion. The present story deals with such instrumentalities and, incidentally, the author has built a marvelous stirring story which cannot fail to impress you.

The Legend of the Mountain

A FLIER was an unusual sight here and the inquisitive inhabitants, men, women and children, crowded around to get a glimpse at the wonderful machine.

There was nothing resembling a hostelry in the village; but, when the worthy Señor Hernando Diaz, its richest citizen, learned that these young men were soldiers like his own three sons who were fighting against the Asiatics in Argentina, he offered his hospitality.

After the evening meal Señor Diaz and his guests repaired to a broad veranda which faced west. For quite a time the three men remained silent. Pelton and Calhoun were absorbed in the grandeur of the mountains over which dusk was settling, and Hernando Diaz knew too well the power of silence and the spell of that majestic sight, to break it with words.

At length Calhoun murmured musingly: "God is up there—God and Peace. Even war couldn't disturb the eternal serenity of those Andes."

He spoke in Spanish. Both Calhoun and Pelton had a fairly complete mastery of that language.

Diaz leaned far forward in his chair: "God in those mountains, Señor? Ah, yes, perhaps in the great peaks far off; but do you see that one which is quite near? It is less than two thousand meters high and at its summit there is a small depression or crater. Madre de Dios—there indeed is the lair of Satan!"

A quizzical smile came over Calhoun's lips. He turned toward the Ecuadorian: "I'm afraid the gentleman you mention has gone north to help with the big row up there. But let's hear the rest of what you were going to say. I'm intensely interested and I think that Joe is perfectly willing to listen too."

"There is a legend about 'The Devil's Nest' which says that in ancient times the Indians made human sacrifices to the sun there," Diaz began in a low voice, while he toyed nervously with

the ends of his curling mustache: "Certainly there is something dreadful about the place still, but no one knows what. In the memory of living men, only two have ventured into it. That was ten years ago. A certain youth named Pedro Menendez was driven by the spirit of adventure, which is the inherent possession of most boys, to scale the heights of 'The Devil's Nest.' He failed to return. Three days later his father ventured up the walls of the extinct volcano in search of him. No human eye has seen either of them since. Truly, it was as though Satan had swallowed up both."

"Men have gone up into mountains before, and failed to return," said Pelton: "There are places where footing is precarious, and crevices in which it would be almost impossible to find a human body. However, we have a little mystery here to solve—George, what do you say if we take a trip to 'The Devil's Nest' tomorrow?"

"Bully enough, old egg," returned Calhoun laughingly: "We've faced devils before, haven't we? They were real devils hurtling at us from out of the sky and shooting streams of poisoned lead dangerously close to our gills. They will probably get us anyway in a week or two and, if we get killed in the mountains, we will at least have the satisfaction of cheating them."

Seeing that argument was useless against such reckless hot-heads, their host merely muttered softly to himself: "They are rash—these soldiers of the United States."

The last pale light had faded from above the peaks of the Andes, a faint wind soughed through the trees. The conversation drifted to other topics.

The Devil's Nest

WHEN the early morning sun of another day had mounted up into a cloudless firmament, the two aviators were preparing for their adventure. Believing that the vigorous exercise of climbing would do their little-used muscles good, they decided to leave the flier behind. Since this was so, they realized that it might be necessary to camp on top of the mountain that night; consequently they packed up a light tent, a couple of blankets and some extra provisions.

Señor Diaz did not urge them to desist from their venture but, when he wished them good luck, Pelton noticed that there was something strangely solemn about his voice and eyes. His attitude was not at all that of a friend bidding him good luck at the outset of a holiday of sport; it resembled, instead, the attitude of a certain fatherly old captain speaking kindly to him when he was about to risk his life in an aerial combat.

When all was ready, Calhoun and Pelton started out up the slopes of the Andes. For a couple of miles the going was easy; but, as they approached closer to the sinister bulk of "The Devil's Nest," the ground grew steep and sterile and the trail more and more difficult.

Calhoun was outwardly in a carefree mood and he scoffed often about the story. "Just imagine, Joe," he would say, "demons and what-not in these mountains that are nearer to God than anything on earth—beneath this blue sky that is the very symbol of peace and beauty! What a superstitious lot the Señor and all his kind are!"

Pelton said very little. Somehow he felt that his friend's lightheartedness was forced, and over his own mind there was coming a sense of depression that increased as the mountain grew more rugged. Was there really some horror in the ancient, extinct crater far above? "No!" he told himself emphatically. The idea was ridiculous; he was a fool even to think of it.

The two men paused to eat their noonday meal at a small level space nearly three thousand feet above the village. The stillness of the place and his own gloomy mood inspired strange thoughts in the mind of Pelton. Finally he turned to Calhoun who was vigorously chewing the last fragment of a ham sandwich (yes—this ancient food still delighted palates of the twenty-second century.)

"Do you think often of Death, George?" he asked.

The other swallowed hard and then smiling slightly, answered: "Death? Well rather. I couldn't help thinking of him now and then, because you see I play hide-and-seek with him pretty nearly every day. He's come to be about my most intimate playfellow, and he's a real sport. He's always 'it' and he never gets sore. So far he hasn't found me, and I will continue to keep out of his way if I can. However, if it's necessary, I'll take my hat off to Death and admit I'm beaten. I'd rather do that than become a slave to those Asiatics."

"I don't fear death in the physical sense any more than you do, George," said Pelton, "but, Lord! How I hate to be forgotten! I'd like to survive this war and live long enough to work out some of my scientific theories. Since I was just a kid I have dreamed of doing something really big and that idea has grown to be almost an obsession with me. You are lucky; even our enemies will remember you as one of the cleverest aerial duelists that ever fought."

"Pshaw!" returned Calhoun; "If there isn't anybody left on earth to remember me but those disgusting Asiatics, I'd rather not be remembered. But listen here, old fellow, I don't think it is the least bit nice of you to make this holiday disagreeable with your glum talk. Just forget it and stow some food and then let's be on our way. The top of the mountain is still about three thousand feet above us, and if we want to reach it before sunset we had better get a move on."

A few minutes later the adventurers continued with their ascent. Now they began to encounter real difficulties; there were rugged, almost perpendicular crags, offering but the barest hand- and foot-holds. These almost baffled the amateur climbers. Here and there were narrow shelves where they could stop to get their breath.

The Blue Crystals

IT was during one of these rests that Pelton noticed crystals of a bluish, semi-opaque mineral clinging to the rocks about him. These crystals appeared to become more and more plentiful as they neared the summit of the volcano. Pelton knew something of mineralogy, but never in his considerable experience had he encountered such a substance. Curious to know its nature, he thrust several pieces into his pack; hoping that some day, if luck was with him, he might analyze them.

Just as the two Americans were starting on the last hundred feet of climbing that lay between them and their goal a large cloud came over the declining sun and an ominous gloom settled over the world.

And now the youths peered eagerly over the rim of the crater into "The Devil's Nest." Five minutes later they had descended fifty feet to its floor.

They found themselves in a small, circular valley about a thousand feet across. Everywhere, topping the walls of multi-colored stone that surrounded it, were pinnacles of the strange blue mineral, pointing toward the sky like the thin minarets of a city of goblins. On the summit of the rocky barrier at the western side of

the crater was a huge mass of the crystal that gleamed darkly under the shadow of the obscuring cloud which hung persistently before the sun.

"This place has more weird beauty than 'The Island of Death'," said Calhoun. "It would make a fine painting. Somehow, there's something about it that gives me a creepy feeling."

There were a few patches of hardy grass and several bushes scattered here and there over the floor of the crater. Suddenly Pelton's searching eyes fell upon a circular spot of bleached earth, not more than ten feet across, lying thirty paces away at the center of the valley. For a moment he scrutinized it intently and then he grasped his companion violently by the arm. "Look, George!" he cried.

A moment later the two youths were bending over a pair of human skeletons whitened by years of exposure. With them there lay several coins, two tarnished brass buckles and the rusted remnants of a few metal buttons. The owners of those bones had obviously been dead for a very long time.

"These are evidently the men that Diaz spoke of," said Pelton, "but what in the name of Heaven could have killed them, George?" There was a look almost expressive of fear in his face.

"Volcanic gases, probably," essayed Calhoun.

"Impossible, man!" returned Pelton; "This volcano has certainly been extinct for ages."

Calhoun knelt down beside the skeletons and began to examine them. "Let's see if there are any marks of violence, fractured skulls, broken ribs, or anything," he said.

Pelton stepped back from the ghastly patch of earth. Never afterward was he able to tell exactly why.

And then a miracle happened—a miracle and a tragedy. The setting sun at last escaped from the cloud that covered it and its ruddy rays, coming over the summit of a nearby Andean peak, fell upon the mass of crystal at the western edge of the valley. A beam of bluish light, like the reflection from the glossy scales of a black serpent and more evilly gorgeous than the slumbering fires of a thousand opals, leaped from it. The ray struck Calhoun squarely. He staggered to his feet, uttered a choking cry, and crumpled lifeless to the earth! A few moments later the sun dropped behind the mountains and "The Devil's Nest" was again in shadow.

Ready for Battle

SIX more weeks rolled by and, now the Asiatic Air Fleet advancing up the Mississippi Valley was only five hundred miles from Chicago. Should this last big city of the Occident be destroyed, all hope for further resistance would immediately crumble; for here were situated the munition factories and here was the government that kept the dwindling energies of the United States organized.

Surrender was useless to the Americans. The blood lust of their foes had grown to such proportions that they had proclaimed that only the complete extermination of Occidentals would satisfy them. In a few more days, when the needed reinforcements had arrived from China, there would be a battle surpassing in magnitude and horrors all previous struggles. Then the men from the East would dump tons of chemicals upon the American metropolis; her twenty million inhabitants would suffer a moment of intense agony and, in a few minutes, she would be left silent and empty. So, at least, thought Tsu Tsin Ho, "The Wizard of the East," and many another wise head among the invaders; for the air fleet of the United States was outnumbered three to one.

But there was one thing that the brilliant Orientals did not know of. In Whitley Park, Chicago's most important pleasure ground, an unusual engineering operation was in progress. Four slender, two-thousand-foot towers of steel, seemingly as frail as spider web, were rising as if by magic. They were arranged in a square and between them skillful workmen were fastening a maze of fine wires.

In the center of the rectangle formed by the towers two enigmatic machines were being assembled. One was a huge apparatus, very similar in appearance to a gas engine of the twentieth century. Fully a hundred feet its eight bulky cylinders reared, gleaming with a glossy black sheen. There was something sinister and awesome about it—a suggestion that within its slumbering frame there lurked sufficient power to send the earth hurtling from its orbit. Beside the engine a great drum-like contrivance was slowly taking form beneath the hammers and riveters of the construction crew. It was a generator that would soon supply energy to the mass of wires overhead.

What was the sinister purpose of this gigantic wireless power plant? Only a few men knew, and these often smiled grimly.

With feverish haste Chicago's factories were turning out new and strange devices by the thousand—things the purpose of which even their builders did not know. They were tubes of varying sizes, from one foot in length to twelve, made of black enameled steel.

The report that the impending battle was very near came sooner than was expected. In the midst of a glorious June day, the sunny serenity of which was mocked by the awful contest that was going on, a lone air scout raced over the city from the south. He brought news that the enemy was preparing every available ship, evidently for the final struggle.

Ten minutes after the arrival of the messenger, a hundred and fifty battleships, America's only reserve force, arose majestically from the landing stage to join the main fleet.

What appeared to be Chicago's last day of life was drawing to a close when they reached their destination. With this reinforcement the American fleet numbered about 2,000 large battlecraft. They hung stationary, supported high above the earth by their gravitational screens, awaiting the attack.

To the south of them, at a distance of perhaps twenty miles, the ships of the enemy were being arranged in battle formation. From deck, port and bridge, keen eyes watched their movements, through powerful glasses. There were at least five thousand of them—all first-class fighting machines of the largest size. Accompanying them was a countless hoard of small fliers.

Now the Orientals began to advance in a great V-shaped arrangement. A thousand feet above them, the one-man craft moved like a swarm of hornets.

Suddenly the position of the Asiatic fleet seemed to change from south to a little west by south in a way that would have made a man of the twentieth century doubt the evidence of his senses. But these latter-day Americans knew well what was happening. It was merely a weird illusion—another creation of Thomas Whitley's master mind. Soon after he invented the gravitational screen, he had found that, under the influence of certain electromagnetic waves produced by a special generator, air could be made to refract light enormously. This discovery was of tremendous ad-

vantage in war. Both the Caucasians and the Mongolians used it to prevent each other from knowing the exact position of their forces. It practically eliminated battles at long range since, without knowing exactly where the enemy is, a gun crew cannot fire with any degree of accuracy. At a range of less than five miles the Whitley "mirafractor," as the device was called, was useless; and consequently within these limits the great contests were fought. At such close quarters the guns shooting projectiles filled with the new radioactive explosive, *terrorium*, could be used with dreadful effect.

The Last Stand

THE Asiatic fleet was quite close now. In order to meet their onslaught the Americans had arranged their ships into three vast rings, one above the other.

Suddenly a light puff of smoke broke from the side of one of the Mongolian aircraft. For a fraction of a second a high, plaintive whine was heard above the roar of rocket-motors. Then, with a report that sounded like the crack of doom, the forward end of an American greyhound of the air was bent into a twisted mass of scrap. Upon the wreckage was spattered a greenish slimy fluid that gave off a gas which turned the shattered flesh of men black, the instant it touched them, and ate into bright metal like a powerful acid, covering it with half an inch of grayish compound.

The titanic struggle had begun—a thundering, hissing maelstrom of destruction. Again and again the Asiatics rushed upon their intended victims and, as often as they did so, they were beaten back by the revolving rings of American aircraft that poured broadside after broadside into their midst.

Losses to both contestants were awful, but among the invaders they were greatest. Time and again a monster dreadnaught gaudily painted with orange suns would crumple up under well-directed *terrorium* shells and take the ten-mile dive to earth, almost completely burying itself in the soft soil. Gradually, however, the Asiatics were getting the upper hand by force of numbers.

After night had fallen the scene of battle was brilliantly illuminated with searchlights and magnesium flares.

In the purple sky the stars glittered as calmly as ever. Though the fates of the human races of the world hung in the balance, nature's serenity was unruffled.

And now the slow retreat of the Americans toward Chicago had begun. Every mile of the way was contested with dogged courage. Time was what the United States needed, and the commander of the fleet meant to gain time if it were humanly possible. "Hang on, men—for God's sake—hang on!" were his constant orders, "If we can delay long enough, victory is ours!"

Set in the revolving turrets at the bow and stern of each American dreadnaught were strange thick cylinders; at the end of each was a mass of glassy crystalline substance, looking like a staring ray. What was the purpose of these queer devices? Many Asiatics wondered. Why was it that they did not flash forth some new kind of dreadful death? Their silence was enigmatic.

Now the contending fleets were a hundred and fifty miles from Chicago, now a hundred, and now only twenty-five. "How much longer must we hold them?" the American commander queried anxiously by radio.

"Fifteen minutes," was the reply. "By then we think that we can be ready. There has been some unforeseen delay of operations at Whitley Park."

And so the Americans continued to fight for time with all the reckless pluck they had to offer.

Chicago stood as dead and silent as though the Asiatics had already dumped their poisonous vapors upon her. Her unlighted skyscrapers loomed up wanly under the blinking stars and her streets were gorges of Stygian shadow. Scarcely a speck of radiance was left to betray her location to the enemy. The inhabitants had shut themselves indoors. A few wept quietly, but otherwise there was no inordinate display of emotion. These people had lost much of their terror of war by constant contact with it.

The Crystal Ray

IN the glow of floodlights, a thousand workmen were laboring like demons on some giant machine that gleamed dimly in the faint radiance. Far, far aloft, supported by four slender towers, was a vast network of wires.

Plainly the finishing touches to the engine were in progress. A hundred men were fastening cables to a two-hundred ton cylinder-head which would in a moment be hoisted into place by an electric crane. Other workers were inspecting and oiling the giant machine.

At one end of the strange titan was a control board bearing many levers, switches and dials; and before it stood the gaunt figure of a man who shouted orders through an amplifier system. It was Pelton; but how greatly changed from the plump young aviator of two months before! His hair was wildly disheveled, and sweat streamed down his shrunken face which, in the wan light, looked almost like a parchment mask hiding the visage of a skull. Lack of sleep and endless hours of labor had wrought this startling change. In spite of his worn condition, there was something magnetic about him that could not help but inspire confidence.

"Crew One, see to the lubrication of the cylinder valves and other parts," he cried; "use the L. F. liquid. Crew Two, examine all the connections of the Z wires. Crew Three, fill the main fuel tanks with the liquid *terrorium* preparation; Crews Four and Five will take care of the cylinder-head. Are all the cables securely fastened? We can't afford another mishap, you know. Good! Now start the crane."

Every man realized that it was vitally important that he should perform his task to the best of his ability in the shortest possible time; and every man responded to the will of his chief with the promptness of a well-oiled machine. In a moment the mass of aluminum alloy soared upward and settled into position.

To the south, and high in the air, a vast oval patch of white light, looking like the head of some enormous comet, had appeared. It had drifted ominously near, and from it there came a subdued roar. In it thousand of insect-like specks flitted, and from them tiny points of radiance leaped as though they were fireflies. It was the battle.

As they fought the two contesting fleets had done their best to get above each other, to gain the advantage of position. As a result their altitude was prodigious. They must have been fully twenty miles above the earth.

"See! They are almost upon us," shouted Pelton. "Hurry! Ten minutes more of delay and we will be too late! Doubtless they are already bombing the outskirts of the city."

With all the speed they could muster the workmen bolted the cylinder-head into place.

"Is everything ready?" cried Pelton.

"Everything is ready," echoed Jerry Armstrong, his chief subordinate.

"Then, stand back, out of danger!" Pelton twirled a few dials on the control board; and then, grasping the big black switch at its center, he pulled it far down. There was a series of ponderous throbs that rapidly grew into an easy humming. The engine and the generator to which it was connected, were in operation. Leaping in the network of wires far above were many bright flashes like the lightning of a violent thunderstorm.

And now all eyes in Chicago had turned fearfully and expectantly toward the monstrous sea of light that was dropping plummet-like from the sky upon the city. The ships were only four or five miles above the ground now, and they could be seen quite plainly in the glow of their searchlights and magnesium flares. The American formation had been broken up and scattered. Apparently there was nothing that could prevent the Asiatics from completely crushing them within the next few minutes. Then they would destroy the city. Already an occasional bomb was falling, like the big raindrops that herald a summer thundershower. They contained the green chemical that gave off the gas which ate into human flesh like sulphuric acid.

With mingled doubt, fear, and hope gnawing at his very soul, Pelton stared at the sky. Had he calculated correctly? For a few seconds nothing happened; then his heart leaped with a mighty exultation! From the bow of one of America's ships a faint beam of bluish light stabbed out and struck an enemy craft, sweeping it from stem to stern! It passed through the vessel as though she had been made of glass, instead of thousands of tons of metal. Immediately the dreadnaught began to blunder oddly as though completely out of control. What had happened to her occupants? A grim smile passed over Pelton's lips, for he knew!

Presently, other beams of blue light awoke—hundreds of them! — thousands of them! And other Oriental craft rushed about crazily, crashing into each other or hurtling earthward. At the very threshold of complete success, the alchemy of fate was changing Asia's victory into crushing defeat.

Pelton Explains

NOW Pelton felt a hand upon his shoulder. Turning he saw that Jerry was standing beside him. The man's face was pale with awe and when he spoke his voice was husky: "Congratulations, Capt. Pelton—here, shake! When it looks black as night, along you come and put those invaders in their proper place. I can't see through this at all. What wonder is it that you have created?"

The fulfillment of his ambition beyond the wildest dreams of his school days had wrought the young scientist up to a pitch of excitement more intense than ever before, "It is the thing that killed Calhoun, the ace," he almost shrieked; "The crystal ray!"

"You mean that your weapon inflicts death with just a beam of light? That sounds impossible."

"But it isn't! I'll tell you about it." Pelton's eyes were glittering and his face was flushed: "Not more than a month and a half ago I was in Ecuador with Calhoun on leave of absence. We explored an extinct Andean volcano of particularly ghastly reputation. There I found a peculiar crystal, which, on analysis proved to be a complex compound of silicon, iron and the hitherto supposedly inert gas, krypton—I call it *andite*.

"It was just by chance that I discovered what terrible things *andite* could do. There was a big block of the material at the crater's western edge. The sun had been obscured by a cloud and, when it came out, its light struck the block, passed through it, and came out as a bluish beam. It hit my old friend and sent him on the long journey west. Thank God, it was not in vain!

"After a lot of effort I learned more about the wonderful properties of the crystal. You know that light is the vibration of an all-pervading medium sometimes called the ether, just as are radio waves. When a beam of light passes through *andite*, its rate of vibration is enormously increased; so that it exceeds by many thousands of times the vibratory rate of even Hadley's Q-ray which is used as an anaesthetic. This supervibration is the crystal ray. It will penetrate four feet of solid lead and a much greater thickness of any other metal. When it strikes a man it produces within his blood a poison that is instantly fatal. The process is comparable with that which goes on in the leaves of a plant when starch is produced by the action of sunlight.

"The projectors of the crystal ray are merely specially constructed radio lamps, equipped with a receiver of wireless power, and fitted with a piece of *andite* which modifies the light.

"After I had learned what my discovery was capable of, I staged a demonstration before the best minds of America. They gave me the cooperation of the whole country and this is the result."

"But what was the necessity of building this enormous power plant?" inquired Jerry: "Couldn't the old stations supply the needed energy?"

"No," said Pelton; "The light produced in the ray projectors must be many times as intense as that produced by ordinary lamps, in order to be effective at any considerable range. Only this new power plant could furnish sufficient energy. The filaments in the projectors would only glow on the power supplied by the old outfits."

Momentarily the roar of *terrorium* shells and the flashing of magnesium flares waxed more intense in the air above. In the few minutes that the big generator had been running, the Americans had annihilated practically three-quarters of their foes. However, a few were trying to escape into the night with their lights turned off. One fifteen-hundred-foot monster was directly above at an altitude of not more than half a mile. Its guns belching with the fury of despair at a smaller but much more agile American ship that was rapidly approaching.

Suddenly the invaders scored a hit. The little vessel crumpled up and fell. The big ship was continuing its retreat away from the scene of battle when a bluish beam, originating from a projector in the neighborhood of Whitley Park, leaped up from the earth and struck it. The ray lingered over the whole expanse of its hull for a second and then died out. The dreadnaught continued to hurtle blindly on its way, its rocket motors roaring full blast. It was headed straight for a skyscraper, and a moment later it struck. A third of the building's height was sheared off; together with the twisted remnants of the ship the mass of steel and masonry fell with a terrific crash into the cleft of a dark street. There the airship still buzzed and hissed like a wounded insect.

A wild impulse was surging up in the breast of Pelton—an intense desire to take an active part in the victory he had done so much to bring about.

He turned to his companion: "Keep the outfit running, Jerry, I've simply got to be in this fight."

As rapidly as his legs would carry him, the young scientist raced to the little shed nearby where he kept his flier. In his hand he carried a small black tube fitted with a pistol grip and trigger. It was a ray projector.

In a moment he had dragged the little craft out and climbed into the cockpit. He turned a dial that operated the gravitational screen. There was a sudden feeling of weightlessness—and then he shot upward amid the gust of rising air.

Three thousand feet Pelton ascended before he started his *terrorum* rocket-motors.

At a distance of perhaps half a mile, a "dog-fight" between countless small craft, was in progress.

At first he thought there was no one in his immediate vicinity; and then, above him and a little to the north, he saw a flier similar to his own, but obviously Asiatic. A bar of opalescence leaped out from the little weapon in Pelton's hand, and the enemy pilot was no more.

The discoverer of the crystal ray was in the act of turning around to join the "dog-fight" when a dozen or more bullets directed with an uncanny accuracy swept down upon him from above. He was unhurt, but a lead pellet had struck his weapon, destroying it completely. When he looked up, clammy fear seized him; for he saw a black flier painted with orange suns and piloted with a fiendish skill, diving straight toward him. Every inhabitant of the United States would have recognized that craft. It belonged to Saku, the ace who had shot more than a hundred opponents from the sky!

Impelled by the instinct of self-preservation, Pelton shut off the power from his gravitational screen. It was all he could do. He thought that perhaps by a rapid dive he could escape the yellow ace; but it was a vain hope. Even as he began to fall plummet-like toward the earth, a gust of poisoned bullets ripped through his body. Probably his sense swam, and it was certain that he felt no pain; for death in those cases is a matter of an instant. Nevertheless a faint smile crossed his lips. Against the blackness of the eternity that poured into his brain, he seemed to see his name written so that people of the future would read with awe, and after his name the words: *"He won the war!"*

THE END

WHAT IS YOUR KNOWLEDGE OF AVIATION?

Test Yourself by This Questionnaire

THE questions given below are taken from the stories in this issue. They will serve, by your ability to answer them, to test yourself in your knowledge of aviation. By thus testing yourself, you will be able to fix in your mind a number of important facts of aviation that are presented by the stories.

The pages, on which the answers are given, follow each question.

1—What is the chief use of Thorium? (Page 444)

2—How could the Autogiro increase its flying speed? (Page 444)

3—What are the advantages of the turbine for airplanes? (Page 444)

4—How is it believed that the sun obtains its boundless energy? (Page 447)

5—Why is the air of the upper atmosphere thinner than nearer the surface of the earth? (Page 451)

6—Who first proved the possibilities of directing a rocket to the moon? When? (Page 432)

7—Why is the rocket plane saved from the deterioration by vibration? (Page 432)

8—How is it possible to reduce "parasitic drag"? (Page 433)

9—What is generally supposed to be the "Fourth dimension"? (Page 415)

10—What limits the possible weight of planes? How could this problem be overcome? (Page 422)

Suitcase Airplanes

(*Continued from Page 429*)

to furnish you with the million planes together with such arms and ammunition as you may need; and I propose to handle the planes in the fight, while you are to man them with two millions of your best sharpshooters who are to do the shooting when I have placed them where they can do the most good. I will also assist myself with my 'Electric Flash.' In payment for the whole cost of this, we will accept——"

Fifteen minutes later, with his "Electric Flash" unloaded of the thousand planes he had brought with him, Sam started his return trip for home. Before daylight the next morning, he had made eleven round trips and the whole outfit was delivered.

Exactly one month after this, Sam stood just at daylight one morning on the heights of the Entotto hills. By his side, his huge "Electric Flash" monstrosity rested easily upon the ground, with the side door open ready for him to step inside. Behind him, on the southern slope of the Entotto hills, two millions of the pick of the Abyssinian soldiers were marshalled under their officers by the sides of one million of the diminutive two-passenger planes. Entirely circling the whole scene, an elaborate "Spark Screen" amudge made the whole thing absolutely invisible from the outside by any known device. At a signal from him, the two million soldiers embarked in the planes and were promptly strapped into their seats.

Then Sam stepped quickly into his "Electric-Flash" monstrosity, and, a moment later, soared to a height of one thousand feet. Here he pushed a button in the "Spark Screen Broadcaster," which lowered that interference to his visibility to a height of five hundred feet, so that, through his "Electro-Visional," he could see everything within a radius of one hundred miles with minute distinctness.

To the west, well within the hundred miles, the extended lines of the English army, estimated at more than ten millions of soldiers, were plainly visible scattered over the mountain tops and down into the deep valleys and gorges. Taking advantage of their "Cape to Cairo" railroad, the English had been the first to mass in force on the western front, and their progress since then had been slow but sure, in spite of everything that all the men, women and children who could be spared from the other fronts could do.

With nervous haste, Sam turned his machine around until it pointed exactly southwest. Then he stuck one of two needles that were attached to a fine copper wire into a point in the "Electro-Visional" dial exactly one hundred miles to the southwest, and the other he stuck into "Local." Then he connected up his "Electric Flash" and also connected it with the helicopter, and he set its regulator at ".0006 Seconds."

Next he turned to a large battery covered with a confusing medley of buttons, and pushed one of the buttons. A moment later, a squad of one thousand of the small planes appeared in the air flying in the direction of the English army's headquarters. Thirty minutes afterwards, they had nearly reached their destination and the soldiers in them had already started shooting wildly at everything in sight, but now they were confronted by the entire English air forces which had taken the air to intercept them. And now Sam hastily pushed another button in the battery, and the whole thousand planes promptly circled in perfect formation and scurried away to the south, with the English air forces in hot pursuit. In another twenty-five minutes, this flight and pursuit had brought nearly the whole of the English air forces practically in line to the southwest—and then Sam, leaving the thousand planes to their own devices for the moment, frantically pulled his helicopter lever, was immediately enveloped in a blinding flash of lightning. Then he caught the answering "tug" of his rear propeller in .0006 of a second afterwards and 111.6 miles from where he started from, recklessly threw out his biplane wings when the "Speedometer" had slowed down to only "500 Miles per Hour," pulled a lever which circled him around and headed him straight back, and pushed another button in the battery which regained control of the thousand planes and started them back home.

In another forty-five minutes, he was flying back over the territory where the English planes had been, and he saw that the ground was heavily littered with the debris. He had missed a few, which were then scurrying back to their headquarters, but, practically, the English were "out of the air."

Exactly one hour and a half after he started his "Electric Flash" drive, he was settled back in his former position with everything straightened out. Then he pushed still another button in his battery, and, presently, a division of ten thousand of the little planes appeared flying in the direction of the English lines. These were quickly followed by division after division of the others as Sam pushed button after button in the battery, until the whole million were in the air.

Thirty minutes later, when they had reached the English lines, the soldiers in the planes started shooting—and now for a few minutes Sam worked like a frantic demon pushing buttons, as he sent this or that division or platoon or squad in this or that direction to "mop up" wherever he saw a sign of life. But with two millions of sharpshooters laying down a solid lead barrage with machine guns, it was all over in less than five minutes.

The next day he repeated on the French 150 miles to the east, and the Italians 150 miles to the north.

"The readjustment of Abyssinia's boundaries which has been agreed upon in the final terms of peace," Sam said one week later in concluding his full report to his boss, Mr. Albert Edward Reginald Gordon-Cummings, "gives them a wide strip to the sea which is protected by natural barriers, and which can easily be defended if necessary. This is probably an unnecessary precaution, for it would be absolutely impossible to induce any nation or group of nations to tackle Abyssinia again—at least not within the present generation anyway—but I insisted that they hold out for the whole thing and play safe."

As he was leaving the office after completing his report, Mr. Gordon-Cummings called him back.

"By the way, Sam," he said casually. "You remember that I fined you one-half day's pay for being late to your work the morning of the day this business started? Well, I've ordered the bookkeeper to refund that to you in your next pay-envelope."

THE END

Beyond the Aurora

(*Continued from Page* 441)

Professor Standish was crouched in a corner, holding upraised in a defensive attitude, a short bar of steel. In front of him, slowly approaching, four of Sharkey's henchmen seemed intent upon injuring the scientist. On the floor lay a man with his head battered to a mass.

"That's all, boys!" Captain Wollack growled, swinging his pistol into line with the outlaws. They raised their hands at once. "Truss 'em up, Professor! These birds have done enough flying!" He turned to them sternly: "You might as well surrender, gentlemen! Sharkey's dead! What's the idea of attacking Professor Standish?"

The scientist stepped forward.

"They tried to force me to change our course and head back to earth, Captain," he said, his features showing his relief at the change of affairs: "I was afraid to do it. Sharkey swore he'd kill me if I wavered!"

Triumphantly the *Tobias Wollack* cruised back to her landing in Washington; Colonel Brigham was there when she arrived, dipping down abruptly from a high altitude. As she neared the landing a stream of fire roared from her velocity-reducing exhaust, and she came to rest gently after skimming along the ground for perhaps a quarter of a mile.

As Captain Wollack stepped out of the control cabin, Colonel Brigham grasped his hand firmly. Scores of newsreel and newspaper photographers stood in the offing, grinding steadily and flashing powder. Professor Standish dodged them and remained within the ship until several police officers entered it. They removed the prisoners at once.

"When I got your television call, Captain," the colonel was saying, "you could have knocked me down with a feather! I've been waiting here for you for an hour! How did you manage it, sir?"

"Oh, I'll tell you about it all later, Colonel," he said, smiling. "Let me rave now about the *Tobias Wollack!* She's a marvel! She's been nearer the moon than anything else that ever left this earth!"

A reporter grasped him by the arm.

"Where's Sharkey, Captain Wollack?" he asked, beaming in anticipation of some sort of a scoop for his paper.

"Sharkey?" the Captain said; "He didn't like our company and insisted on quitting it! We had to drop him off beyond the aurora!"

THE END

Editor, AIR WONDER STORIES,
98 Park Place, New York City.

I have checked on the coupon below, the stories I like best in this issue and have listed them in the order of my preference:

1

2

3

4

5

Remarks and suggestions:

Name

Address

City . State

The Second Shell

(*Continued from Page* 451)

My guard climbed through, suspicious and in haste, evidently unconscious of the beam. I slipped the tube under my coat, to hide its crimson glow, playing the ray over him again, and over the mechanics and my two fellow-passengers, as they came through. I heard footsteps, and a light flashed on. I saw that we were in a long, low room, with a door at the farther end. Four men, in red uniform, with rifles, were approaching. Hopelessly, I gave them the benefit of the ray, but still nothing happened.

'Move on, Pard," my guard muttered. "The Master waits." He gave me another vigorous prod with the blade. (He seemed to enjoy his prerogative immensely.)

I still had the tube in my hand, concealed against my coat. Though it seemed to have no effect, I was missing no chances. We passed through a door at the end of the room, into another fitted up like a luxurious office. At a paper-littered desk, the lunatic, Vars, was sitting with three other men, who, for all their looks, might have been ex-pugilists or bootlegger kings (or both).

Suddenly Vars ducked, and a pistol flashed at his side. My hand went numb, and I heard the crash of glass. He had shot the tube as I turned it upon him. As he cursed and fired again, I threw myself at the feet of the fat man. Pistols cracked, and I felt the wind of bullets. Strangely, the big fellow collapsed as I dived, striking the floor at my side.

And then a fearful thing threw itself at me!

It was a many-tentacled creature of luminous purple fire, with an eye-like nucleus of bright scarlet in its shapeless, semitransparent body! It was a thing or horror like that which had looked upon me as I lay in the cell—a nightmare being! I struck at it feebly, reeling in terror.

It had followed us into the room; it must have been the pilot of our ship.

Slender tentacles of purple fire coiled around me. They touched me. Their touch was cold—cold flame! But it burned! I felt a tingling sensation of pain—unutterably horrible. The contact with that monster shocked like electricity—but it was as cold as space!

I shrieked as I fell!

With my last energy, I sent out my fist at that flaming scarlet core. My arm went through it, cut it!

Then I have a confused impression of cries of agony and terror, of men cursing, screaming, falling. There were pistol shots, shouts, and dreadful sobbing gasps. I sat up, and saw that the room was full of writhing, dying men! Corpses weirdly splashed with red!

And the purple thing lay before me on the floor, inert and limp, with the fire in it fading. Still it was unspeakably horrible.

Then I heard Ellen cry out, calling my name! I ran on in the room. Ellen stood at the bars of a flimsy little door back of the desk at which the men had been seated.

"Bob," she cried, "I heard you! I knew it was you!"

I smashed the door with one of the rifles. The girl ran out to me, with Bill and the Doctor at her heels. The Doctor took in what had happened.

"The r-r-r-ray made slow p-p-p-p-poisons in their blood. Not adjusted right. It can upset the chemical equilibrium of the body in a thousand ways. But let's get b-b-b-back in the other ship before something happens."

We got through the manhole. I closed it again and unfastened the clamps that held us to the other ship, while the Doctor and Bill ran forward into the pilot's compartment. I felt the vessel rise.

Ellen and I stood by one of the round ports. We saw the weird red city drop away below us. Soon the flat, desolate purple desert was slipping along beneath us, with the green-gray earth visible through it, so far below.

And still there was no movement from the city.

We were several miles away before I saw the red ships rise in long lines from their places on the landing deck. Our flight had been discovered! And then I saw the great dome moving, the slender tube pointing at us.

They were going to use the ray!

The Doctor's voice came from the forward compartment. "I was afraid something would happen to the p-p-p-p-plans. You know I told you that I almost had an atomic explosion of the molten Vernonite electrode. The specifications on the blue print were almost right—almost—"

A great flare of white light burst from the transparent dome. A blaze of blinding incandescence blotted out the scarlet metal city. After a long moment it was gone, and we could see again. The city in the sky was no more!

There was only a vast ragged hole in the purple plain!

That was perhaps the most terrific explosion of history, but we neither felt nor heard it, for we were above the air.

* * * * *

That is a year ago, now. Ellen and I are married. Soon we shall go back to El Tigre, to see the Doctor and Bill. Dr. Vernon is working on a new model of his tube, and is making a painstaking examination of the strange ship we brought back to earth.

Did the destruction of a single city destroy the menace? In all that world above the air, larger than our own, may there not be other cities, or nations and races, perhaps, of intelligent beings? What might we not gain from them in the arts of peace, or not lose to them in war?

This summer the four of us are going to adventure above the air again, in that captured ship—to explore the Second Shell.

THE END.

AVIATION NEWS OF THE MONTH

CONSTRUCTION

Helicopter Still Far From Success

THE helicopter is still far from success, says Hiram W. Farr in *Aeronautics*, and, despite what ambitious manufacturers claim for their products, no dependable machine to rise and descend vertically has yet been invented. There are certain standards to which a helicopter ought to measure up and some of these, elaborated by Professor Alexander Klemin, head of the Guggenheim School of Aeronautics, are mentioned. The machine must be able to climb vertically with a moderate amount of useful load, it must attain a reasonable ceiling; it must achieve vertical descent on a steep path with dead engine; it must have a reasonable horizontal speed, and it must be fairly stable and completely controllable. Altho many machines of the helicopter variety can climb vertically, when their sustaining apparatus goes dead they will fall to earth like rocks. It is impossible to have wings on them, because that would destroy their lifting power. Few of them have achieved any reasonable speed, and they are certainly not yet entrusted safe.

Giant Movable Dirigible Mast at Lakehurst

NOW being experimented on by the Navy at Lakehurst, New Jersey, is a giant movable dirigible mast. At present it is being used for the great rigid airship the *Los Angeles*. Its designer is Commander Rosendahl, former commander of the *Los Angeles*.

The device consists of three derrick-like towers mounted on three great caterpillars two of which are fixed and the third movable like a tricycle. A great tank furnishes the power. The towers are connected together and form an equilateral triangle. There is an elevator which can be raised or lowered by machinery operated from the top of the combined structure. The purpose of the device is to remove the necessity of four hundred men pulling a ship to and from its hangar when it settles to earth or is leaving. By means of the equipment the ship is anchored to the structure and the tank moves it neatly and with despatch into its hangar. At present the berthing of a ship or getting it ready to leave the hangar is an expensive manner, so expensive that it is stated that if the Navy Department had not given the *Graf Zeppelin* the use of its personnel free of charge it is doubtful whether the recent trips from Germany or the around the world trip would have been started.

815-Mile an Hour Goal Set for Flyers

A NEW goal for the speed of man's flight through the air has been added to those which he already had. Dr. L. O. Howard of the U. S. Bureau of Entomology, according to the *New York Times*, mentions a deer fly which attains a speed of 815 miles an hour and maintains it for several hours. The fly is a marvel of mechanical perfection, being exceedingly light in weight and possessing powerful wing muscles. Our airplane designers should study this little insect for, as Dr. Howard says, speed in flight is nothing more than a matter of mechanics. Dr. Townsend, formerly of the Bureau of Entomology, states that we must really look to the insect world for guidance in building our future planes. The deer fly could fly from New York to Paris in three hours, for it has not only speed but its own reserves of fuel. It is also mentioned that, in the Langley Laboratory at Langley Field Va., experiments are being made with enormous velocities to determine the ability of planes to withstand them. In one experiment a jet of air rushing at the speed of sound is directed against propeller blades. The aim that man has apparently set for himself is the circumnavigation of the globe in a single day. The development of superplanes, as well as superpilots, is hoped to make this possible.

Bleriot Sees Floating Docks Coming

BELIEVING that the floating docks for air liners recently proposed by an American will come to pass, Louis Blériot, who first flew the English Channel, predicts regular ocean travel within ten years. The world has now celebrated the twentieth anniversary of Blériot's historic flight on July 25, 1909. He believes that seven or eight floating stations between American and France or England would solve the problem readily.

Giant German Plane Tested

THE great German plane of Dr. Dornier, the DOX, has been successfully tested in Germany. Designed to carry a pay load of 11 tons or 22,000 pounds the craft, which is a seaplane, has a wing spread of 225 feet. It can travel at 150 miles an hour, although its cruising speed is 120 miles per hour. It is powered by twelve motors in tandem. It has a main deck sixty-four feet long. All the motors will be controlled from a single engine room. There will be an engineer with four assistants to operate the motors. The plane can carry 120 passengers. In its test over Lake Constance the plane took off from the water in 28 seconds.

Manufacturers Building Planes on Wrong Principles

C. B. ALLEN, writing in the *New York World*, alleges that airplane manufacturers are placing the industry in a rather chaotic state by their short-sighted policy in designing planes. Instead of approaching the problems from an aerodynamic point of view, and cleaning up their designs so that they have the greatest structural strength and reserve power, he claims, they are trying to crowd all the horsepower possible out of the motors and are reducing safety-factors to the lowest point consonant with Department of Commerce regulations. Many planes, made trimotored for safety, have been so loaded up that the safety-factor of multiple motors becomes "a mare and a delusion for the unsuspecting public." An instance of a far-sighted designer is cited in the case of Giuseppe Bellanca, who is developing, from the 200-horsepower Whirlwind motor used by Lindbergh, Chamberlin and others, a 500-horsepower motor with the same weight of plane. This gives the plane a greater speed range, and provides a "cushion" or reserve of power in case of emergencies.

Oceanic Airship Lines Not Yet Feasible Says Burney

COMMANDER SIR CHARLES D. BURNEY, in charge of the great British dirigible R-100 says, "that we are not yet ready for regular trans-atlantic service by dirigibles. In order to make the thing feasible from a practical standpoint, a cruising speed of 90 miles an hour must be maintained and in order to do this the present size of the ships must be doubled. Instead of having ships of 3,500,000 cubic feet capacity, which is the size of the *Graf Zeppelin*, the ships must have 10,000,000 cubic feet, with 300 tons displacement instead of 150 tons at present. And even if these ships could be built now it would be costly to land them. A new method of working out the landing problem must be made."

Sir Charles however does not decry the dirigible. He believes that unless a new principle of heavier-than-air craft is developed, the commercial planes will not be able to rival the dirigible. He sees his own ship the R 100 already able to cross the Atlantic without passengers. It has been designed, however, for other service and it is not built for the speed so necessary for trans-atlantic work.

Motors in Wings in New Plane

A NEW Junkers 50-passenger plane is being developed which will have its four motors mounted in the wings, two on either side of the fuselage. This machine will be a departure from the standard Junkers type in that the older models used the wings for the accommodation of passengers and freight. There will be two 800- and two 400-H.P. Junkers engines to power the machine, giving 2,400 horse-power in all. This construction is intended not only to have aerodynamic advantages but also to promote ease of inspection and repair of motors during flight. Because of the wing span of 44 meters (about 144 feet) there is necessary to afford stability to the plane a new tail steering gear, consisting of two horizontal planes, one above the other, attached to which are two rudders. Thirty-two berths for night flying are possible in the plane which will develop a speed of 170 kilometers (110 miles) an hour.

Adjustable Propeller Will Increase Efficiency

BY designing their blades so that the pitch can be adjusted, the efficiency of the propeller screwing the plane through the air will be increased, is the opinion of members of the Society of Automotive Engineers. It has been found that, as the speed of the plane is changed, the efficiency of the propeller changes with the varying slip thru the air. It is proposed, therefore, that a small electric motor activated by a storage battery be geared to the propeller to provide the means for changing the pitch of the blades.

Cierva Predicts Popular Ownership of Autogiro

EVERY man who has thirty square yards of ground can own his autogiro plane, declared Sr. Juan de la Cierva, inventor of the autogiro plane which is able to take-off without a run and land on any spot desired. According to the *New York Times*, Sr. Cierva is now in this country, where he has conferred with officials of the Pitcairn Aviation factory, which owns the American rights to the autogiro. Sr. Cierva believes that his planes can be manufactured in large numbers to sell at the cost of a medium-priced automobile. The plane has four revolving vanes atop the fuselage, set on a vertical axis, this being the means of adjusting the vertical flight. Sr. Cierva conceived the autogiro principle in 1920 when he was 24 years old. His plane will be entered in the $100,000 Guggenheim safe-aircraft competition.

Autogiro Makes Perfect Landing in Test

IN A recent test of his autogiro, Sr. Juan de la Cierva landed his machine without any rolling or skidding on the ground, thereby demonstrating the capacity of the machine to make what might be termed the perfect long-sought-for landing. This test was made at the Pitcairn flying field at Bryn Athyn, Pa. During the tests, the inventor also showed how his machine could make a takeoff in about one half the run required by an ordinary plane. Even autogiros in the past have had to do quite a bit of taxiing before a takeoff. Now, with an arrangement whereby the air stream from the propeller starts the "windmills" automatically it is not necessary to get up a certain speed before rising. The inventor was also able to set the machine, while in flight, at a stalling angle and do tricks which would have meant death in an ordinary plane. It is expected that the autogiro can be operated with much less skill than an ordinary plane, this will effectively cut down the time necessary for novices to learn how to fly.

OPERATION

New Speed Record 358 Miles an Hour Made

A NEW world record for speed of human travel was made by Squadron Leader Augustus H. Orlebar, in the supermarine plane, Rolls-Royce S-6, when he attained an average speed of 357.7 miles an hour over a three-kilometer course on Southampton Water, England. This record betters by 25 miles the record of 332.8 miles an hour made by Flying Officer Richard Atcherley in the 1929 Schneider Cup race, and is 37 miles an hour faster than the official record of 318.6 miles an hour established by Major Bernardi of Italy last year. Orlebar is said to have complained of a 15-mile wind which delayed him, and also stated that he had on other occasions flown faster than 355 miles an hour on a straight course. Several times Orlebar dived, meteor-like, from a 1500-foot level to gain speed and, flashing past all objects, he made the fastest moving things about him seem motionless.

Lieutenant George Stainforth also broke the previous record with a speed of 336 miles an hour.

Airplane Attached to Airship in Flight

THE rather spectacular feat of attaching an airplane to the airship *Los Angeles* while in flight, and transferring himself from the plane to the ship and then back again, was accomplished recently by Lieut. A. W. Gorton. Flying a small Vought biplane, Gorton flew close to the airship and tried to attach a steel shepherd's crook, built upon the plane's upper wing, to a metal trapeze that hung seventeen feet below the ship's hull. It was close work, because the part of the ship where the trapeze hung is flanked on either side by gondolas of the ship. Three times the flyer nearly made it, but each time the hook slipped away. At the fourth attempt, a tight contact was made and the crew of the airship pulled the plane snugly against the ship. Gorton then transferred himself via the cockpit and wing to the airship, and then returned to unhook his ship and fly away. All this was done in the face of a forty-five knot gale.

Telephone From Air to Be Regular Service

FOLLOWING many experiments of telephonic communication between airplanes and the ground, it has been announced, according to the *New York Times*, that in the near future telephone switchboards would be equipped to receive and transmit calls regularly from the air. The Universal Aviation Corporation plans two-way radio communication equipment on all planes enabling pilots in flight to converse with airports. These will be installed on the coast-to-coast, air-rail route of the company. Conversations, according to tests made, can be carried on over a distance of twelve hundred miles. While the service, at first, will be primarily for the pilots, it is understood that it will be very easy later on to extend it to passengers; who will then be able to converse with almost any telephone subscriber in the country.

300 Miles an Hour Normal Speed in Future

SIR Alan Cobham, noted English aviation authority, believes that 300 miles an hour may become the normal cruising speed in planes of the future, says the *New York Times*. Although such a speed is a figure now aimed at in speed contests such as the Schneider Cup races, Sir Alan believes that the information gained from such races will enable builders to construct planes easily capable of sustained travel at this rate. Sir Alan therefore does not agree with critics that speed contests are unwise and dangerous, and gain us nothing. It is only when a machine is put to an extreme test that its weaknesses and good features become evident. He notes that when the steam locomotive was first invented 30 miles an hour was once considered the maximum speed at which humans could travel. So also, with the coming of the airplane, 100 miles an hour was deemed an impossible speed. Sir Alan sees the only reasonable limit, to determine the speed of a plane, in the economic factor; determining that figure at which the cost of operation is minimum.

Machine-Gun Camera Records "Hits"

BY PLACING a camera on machine guns with which army fliers practice, it will be possible to obtain a record of what "hits" have been made. The regular type of machine guns will be used but, instead of firing bullets when the trigger is pressed, the camera attachment takes a series of pictures showing where the bullets would have hit. The times at which the shots are fired will also be recorded on the camera film. These cameras will be used in army maneuvers and "battles" and the umpires of the battles, deciding which planes should have been shot down, will determine this from the records. These camera attachments are being made by the Fairchild Aerial Camera Corporation.

Radio Beacon Marks Out Twelve Courses

THE Bureau of Standards, cooperating with the Department of Commerce, has developed a new radio beacon which allows an aviator to pick out any of the twelve different courses and at different angles. Set on the pilot's instrument board is a three-need indicator which gives him his guidance and enables him, though "lost," to find out which course he is on. This new device has been made necessary by the growing complexity of routes surrounding large airports. The multi-directional beacon uses a three-phase transmitter. Several of the transmitters have been ordered, according to Captain F. C. Hingsburg, chief engineer of the Airways Division of the Department of Commerce, and will be installed for operation as soon as received.

"Aviation News of the Month"

portrays in plain, yet concise language every important aviation advance during the month. Nowhere can the average reader get such a wealth of accurate and vital information condensed into such a small volume. Some 40 aviation magazines and newspapers are utilized by our editors in the compilation of this department. The publishers welcome short contributions to these pages from the various scientific institutions, laboratories, makers and distributors of planes, etc.

Zeppelin Trip Shows Need of Air Preparedness

THE flight of the *Graf Zeppelin* across the Pacific in three days has reduced that once "boundless expanse of water" to a "narrow strip," says the New York *Sunday American* editorially; and it has placed before us the urgent need of protecting ourselves from attacks from the air. Once, we considered that oceans on either side of us were reasonable safeguards from attacks in case of war. But ships like the *Zeppelin*, capable of carrying tons of explosives, and having very wide cruising ranges, bring within possibility the destruction of our cities by enemy invaders. The editorial asks for an air fleet for the nation second to none. The government should itself develop aviation instead of relying on private initiative and should have a fleet of aircraft so large that nations would hesitate to attack us and always be in fear of reprisals by us if they went to war with us. The air forces should not be mere arms of the army and navy, but independent forces. The editorial suggests that an air fleet used by the post office for the carrying of mail should be readily convertible into war planes capable of carrying bombs, poison gas and machine guns.

Conference to Study Better Plane Radio Reception

IN order to improve the radio reception of planes by shielding engines, a conference is being held at the Bureau of Standards at Washington. The purpose is to coordinate the knowledge now extant about shielding, to standardize the standardization of shielding practices and establish better methods of testing so that the effects of various types of shields can be determined. The conference is being attended by not only the commercial interests, manufacturers of planes, engines, magnetos, but research organizations and government employees concerned. It has been found that the various parts of the ignition system must be enclosed in metal shields with a high conductivity.

Lindbergh Favors Dirigible Line

"THE dirigible as now developed is superior to the airplane for transoceanic flying," said Col. Charles Lindbergh recently. The recent trip of the *Graf Zeppelin* has demonstrated the practicability of the lighter-than-air ships. He sees no conflict between them, and believes that development of one is bound to increase the use of the other. He also expressed the hope that there will be a dirigible air line in the United States. He also expects that 100-passenger planes will come to this country soon, and that the time consumed in the transcontinental flight would be materially reduced.

Graf Zeppelin's Trip Proves Airship's Flexibility

THE recent successful round-the-world tour of the *Graf Zeppelin* has proved one superiority of the rigid airship over the heavier-than-air plane, says Lauren D. Lyman in the *New York Times*. The airship has an element of flexibility, obtained through its great reserves of fuel that permit it to deviate from its route and escape storms and fogs. Also it cannot make an unalterable schedule, such as is necessary in the transcontinental air routes, and fly right through any kind of weather as the heavier-than-air planes must, yet the airship can make a longer flight than the plane, and at a more leisurely rate. Mr. Lyman believes that the controversy between airship and plane is more imaginary than real and that the reasonable solution is to use each in its proper and natural sphere.

Nations Cooperate for Atlantic Weather Service

AS A result of a recent conference of meteorologists at Copenhagen, says a New York *Times* editorial, plans for the establishment of an international weather service on the Atlantic seem to be afoot. In the past, not only has the lack of adequate information on Atlantic storms seriously hindered ship navigation, but to it is attributed also the loss of a number of lives in airplane attempts to cross the ocean. What is proposed now is that ships supplied by each interested nation be designated as weather-gathering units; the United States would provide twenty, Great Britain thirty-two, France five, etc. They would carry powerful radio sets and keep coastal stations supplied at all times with data on the weather. Commercial air travel, says the editorial, can never flourish until weather forecasting is as accurate as methodical reports can make it.

Regular Zeppelin Oceanic Air Lines

AS A result of the successful round-the world tour of the *Graf Zeppelin*, plans are now being made which may end in the establishment of two oceanic air lines. With officials of the Goodyear Zeppelin Company of Akron, Ohio (which is building two huge airships) and prominent bankers, Commander Eckener and other German officials are discussing the possibility of a Pacific and Atlantic service. The plan is to have two air liners, each twice as large as the *Graf Zeppelin*, to ply between some Pacific port and either Honolulu or Tokio. There would also be one or two liners running on regular schedule between an Atlantic port and Europe. Paul W. Litchfield, president of the Goodyear Company, indicated that capital is already available for building the ships contemplated.

AVIATORS

New Endurance Record Made by Civilian Flyers

BY remaining in the air above Fort Worth, Texas, for 172 hours and 31 minutes, Reginald L. Robbins and James Kelley broke the world endurance record for continuous flight by more than 21 hours. The previous record of 151 hours was established early this year by the *Question Mark* piloted by Army flyers. The plane used, called the *Fort Worth*, was a used machine with a Wright Whirlwind motor. It had previously been flown about 500 hours, and the pilots intended to stay aloft until the machine knocked itself to pieces. But a battered propellor, and excessive vibration in the machine ended the flight, with a new record, but short of the 200-hour mark hoped for by the flyers. The *Fort Worth* flew altogether over 10,000 miles. It carried 250 gallons of gasoline and was refueled every 24 hours with 100 gallons.

Ten-Mile Altitude Goal Sought

ATTEMPTS to raise the altitude record of planes to 10 miles are now being thought of by aviators, according to Lieut. Apollo Soucek, who has made many successful altitude flights. Although present airplane construction and the equipment for the aviator limit the altitude to about eight and a half miles, many new improvements are being devised to care for the unusual conditions existing above that level, lighter planes, made possibly of magnesium, special furlined clothes and electrically heated goggles, means of providing sufficient pressure for the plane to maintain the lift. Balloons without passengers have already been sent as high as twenty-four miles where the weather and atmospheric conditions have been studied. These studies are expected to provide data on which the equipment for altitude record-seekers will be based. One of the chief difficulties is in obtaining oxygen for the aviator and another is the obtaining of oxygen for the motor. The first is taken care of by oxygen flasks that the aviator takes with him and the second by superchargers which pump air in faster and give almost sea-level atmospheric conditions. But beyond seven miles the conditions become so bad that even these two aids begin to fail. Lieut. Soucek predicts, however, that planes should reach the 10-mile level within the next ten years.

"Aviation" to Discourage Atlantic Flights

AVIATION, a weekly devoted to aeronautics and edited by Edward P. Warner, former Assistant Secretary of the Navy for Aeronautics, has editorially declared itself against oceanic flights that have not as their aim the extension of our information or to make real contributions to aeronautics. The great number of failures undertaken hastily and without lack of experience or proper judgment has tended to impair confidence of the public. No one has really improved on what Lindbergh did in 1927, says the editorial. In order to discourage flights for publicity or personal glory the paper has adopted the policy of not mentioning in its news columns or editorials such flights. In this way it is hoped that such flights shut off from publicity will be discouraged.

School for Airship Pilots Started

THE first school for the training of airship pilots has been started by the Goodyear-Zeppelin Company at Akron, Ohio, in conjunction with Akron University. Twenty-five members of the Goodyear personnel will receive full instruction paralleling that of the Navy pilots on the construction and operation of lighter-than-air ships. The students must study also the balloon and be able to pilot a balloon before being allowed at the controls of the motored ship. Instruction will also be given in heavier-than-air craft. But the real course is designed to provide a selected group of men with the means to pilot the temperamental and elusive airship.

New Altitude Record 39,140 Feet

THE official certification of a new altitude record of 39,140 feet was awarded to Lieut. Apollo Soucek, the Navy aviator. A report to this effect was submitted by the Bureau of Standards to the National Aeronautical Association. This record tops by 722 feet the old record of 38,418 feet established by Lieut. C. C. Champion, also of the Navy, in 1927. The calibration of two barographs carried by Soucek provided the means of determining the altitude reached. One of the interesting devices used in the plane was a Hoots Supercharger which was designed to reproduce in the motor the same atmospheric conditions that are obtainable at lower altitudes. A complete transcript of the flight will be forwarded to the International Aeronautical Federation's headquarters at Paris.

GENERAL

Guggenheim Fund to Study Air Insurance

A COMPREHENSIVE study of the question of air insurance, now becoming an important one, will be undertaken by the Daniel Guggenheim Fund for Aeronautics. The study will be directed by Captain Dunn, who is a consultant to the Fund. Because of the lack of information on air risks, what they are and which are the most important, the rates at present are prohibitive. The information that Captain Dunn will obtain will be made available to the insurance companies. At present the lack of reliable information has made what is called a confusing situation with wide variances in rates.

Bombing Planes Demonstrate Great Mobility

A RECENT demonstration proved conclusively, according to C. B. Allen, aviation editor of the New York *World*, the great mobility of bombing planes. Eight Hornet motored, Keystone Panther bombing planes took off from Langley Field, Virginia and in forty hours had reached San Diego, California. The planes made only three stops en route. The ships when fully loaded weigh 13,000 pounds and have as armament not only bombs but five machine guns for offensive and defensive purposes. The feat is considered to be of great importance not only to the offensive but also to the defensive scheme of the nation. It is now possible with unheard-of rapidity to shift the strength of the air forces from any point in the country to another. During the trip the planes not only maintained communications with each other but also with the ground. It should be said, however, that in the present flight the space that was normally occupied by 2,150 pounds of bombs now held special gas tanks which increased the range of the planes from their normal 600 mile range, to 1,500 miles.

Fly-by-Night Air Schools to Go

STATE laws designed to stamp out the fly-by-night flying schools which have not the personnel nor equipment to properly conduct a school, are urged by Dr. James Sullivan of the New York State education board. He mentions how a good many requests for licenses are received by enterprises which call themselves "engineering schools," yet present no evidence of their being such. Many so-called "flying schools" are also refused licenses because of a doubt as to their educational character. Since the Department of Commerce is already working on regulation to govern flying schools, New York state officials are expected to confer with the Commerce Department officials to arrive at some uniformity.

"Enplane" and "Deplane" Added to Dictionary

TWO new words to express the acts of a passenger entering an airplane and leaving one are to be found in "enplane" and "deplane," which the New Standard Dictionary has added to its list. These, says Dr. Frank Vizetelly, editor-in-chief of the dictionary, are parallel words to "entrain" and "detrain" as applied to train passage and "embark" and "debark" as applied to ships. The addition of these words illustrate how our language is changing in proportion to the change in our mode of living and our customs.

Air Police Force for New York

IF the plans of Police Commissioner Whalen are adopted, New York City will soon have four amphibian planes to protect its citizens from the hazards of the air. This step is to be undertaken as the result of recent casualties caused by aircraft accidents in the city. The commissioner is said to have remarked that he foresees a time not far distant when thousands of people will be flying, and that means to protect non-flyers must be considered now. If necessary he is ready to recommend the requirement of a municipal license for flying within city limits; stating that municipal or state action might be necessary to supplement federal authority.

25,000 Foot Chute Jump Sets Record

A NEW altitude record for a parachute jump, is believed by the Ryan Aircraft Corporation to have been set, when Jimmy Donahue, well-known parachute jumper, left a Ryan brougham piloted by O. N. Mosier over the municipal airport at Colorado Springs (near Pike's Peak) at an altitude of 25,400 feet, during a recent air meet.

The record is unofficial as yet, but will be verified as soon as the barograph can be checked. The descent took 19 minutes, and Donahue drifted two miles south of the airport. The Ryan without special equipment climbed to the 25,400-foot altitude in 42 minutes. The plane was still climbing when the extremely low temperature forced the pilot to descend, because of lack of special clothing.

Despite the record height from which the jump was made, Donahue descended at the rate of only about 15 miles an hour after his parachute opened. He landed without injury.

Letters on Plane Denote Classification

BEFORE passengers enter a plane, if they wish to determine the standing of the plane before the law, they may do so by observing the letters preceding the plane's number, says the American Air Transport Association. A plane with the letter "C" has been permitted to make interstate trips with passengers and one with "NC" is permitted also to fly to foreign countries. "S" means that the plane is in government service and "X" denotes that it is for experimental purposes only. A plane with "E" on it means that it has not yet been licensed. Only planes with the designation "C" or "NC" should be used by passengers for perfect safety, warns the Association.

Two Schools Wage Battle on Ultimate Plane Size

WITH the plans afoot for a number of gigantic planes, there has come to the front the battle that has always existed between the two schools of aviation experts on the ultimate size of the plane, says T. J. C. Martyn in the New York *Times*. Dr. Dornier whose 100-passenger plane has already made a successful trial flight is enthusiastic about large planes. He believes that his DOX is a living refutation of the theories of the "small plane school." The latter hold the belief that as the size of the plane increases the weight increases more than proportionately. In other words a large plane would become so heavy that it would necessitate a wing area extraordinarily large. Dr. Dornier as the result of his studies does not believe this altogether true as there are some compensating features as the size of the plane increases.

The commercial necessities, at least, are all on the side of large planes. The personnel necessary to operate a plane does not increase proportionately with the number of passengers carried. Thus there is an economy in having large planes. Further there is possible on large planes many features for the comfort of passengers impossible on those of small size. Thus the DOX may have electric kitchens, a bar, dining room, and well-laid out sleeping quarters. These things however if finally installed may cut the passenger capacity down to 50 persons.

Mr. Martyn believes that the dirigible will be able to carry passengers in greater comfort than the airplane and on this score it has an advantage over the heavier-than-air machine. The dirigible also can carry heavier loads than planes as now developed. Theoretically, he says, it would be possible for a dirigible to carry 1,000 passengers and a vast amount of freight. But he believes it is a rash prophet who would predict which type will ultimately [illegible].

(Continued on Page 466)

THIS department is open to readers who wish to have answered questions on Aviation. As far as space will permit, all questions deemed of general interest to our readers will be answered here. And where possible illustrations will be used to answer the questions. Queries should be brief and not more than three should be put in any letter. Address all communications to the Editor.

The Cantilever Wing Explained

Editor, Aviation Forum:

When you first put out AIR WONDER STORIES, I immediately sent for the first copy. I have now subscribed and received the August and September issues. The stories are all very good and I will not comment on any of them, except "The Ark of The Covenant," by Victor MacClure.

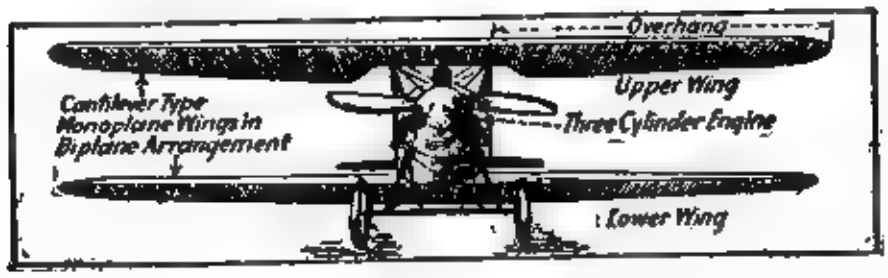


Illustration of an Arrow Sport Biplane having both the Cantilever supported and tapered wings.

Note the fact that the wings are supported only at the

From "*Modern Aircraft*" by Victor Page. Published by Norman D. Henley Co.

This is about the best aviation story I've ever read. I wish the author would give us a sequel to it.

Being a student of aviation, I have a few ideas I want corrections on. They are as follows

(1). I understand a *cantilever* aerofoil, or wing, to be a wing which is thicker at the center, measuring from tip to tip, and thinner towards the tips. Is this correct?

(2). I understand a tapered wing to be a wing whose chord is greater at the center and smaller at the tips. Is this correct?

MARGARITO MARTINEZ,
Box 939, Morenci, Arizona.

(1. A cantilever wing is generally thicker at the fuselage (root) than at the wing tip, but it is not that fact that gives it its name. The cantilever wing is one that is braced only at the root—it has no external braces under the wing to support it. The reason for the fact that it is thicker at the root is that the bending force on the wing's cross-section is greatest there, and so the cross-section must be made greater to sustain it.

2. A tapered wing is one whose chord (the distance across the wing from nose toward the tail) is greater at the root than at the tip. Tapering is a method also used to adjust the cross-section of the wing to take care of the variation in bending "moment" or strain at each point on the wing. The accompanying illustration shows a cantilever plane with tapered wings.—*Editor.*)

Some Speed Records

Editor, Aviation Forum:

I would be very much obliged if you would answer the following questions.

(1). Who made and when, the first non-stop trans-Atlantic flight?

(2). Who made and when, the speed records of the following? Also what were the records in miles per hour?

a.—Airplane
b.—Hydroplane
c.—Race-car
d.—Speed boat.

(3). Date of Col. Charles A. Lindbergh's birth.

I thank you

R. J. SMOLIK
Fernie, B. C., Canada.

(1). Captain John Alcock and Lieut. Arthur Brown made the first non-stop flight across the Atlantic, flying from St. Johns, Newfoundland, to Clifden, Ireland, on June 14, 1919.

(2). a and b—The airplane speed record is held by Squadron Leader Augustus H. Orlebar of England who, on September 12, 1929, made 357.7 miles per hour. Inasmuch as Orlebar used a supermarine plane, his record can be considered the seaplane record also.

(2) c. The record for racing cars is held by Major Sir Henry Seagrave of Great Britain who at Daytona Beach, Florida, made over 231 miles per hour.

(2) c. The speedboat record of 93 miles per hours is held by Gar Wood of the United States, who made the record in 1929.

(3). Charles Lindbergh was born on February 4, 1902.—*Editor.*)

What Happens to Gravity-Insulated Planes

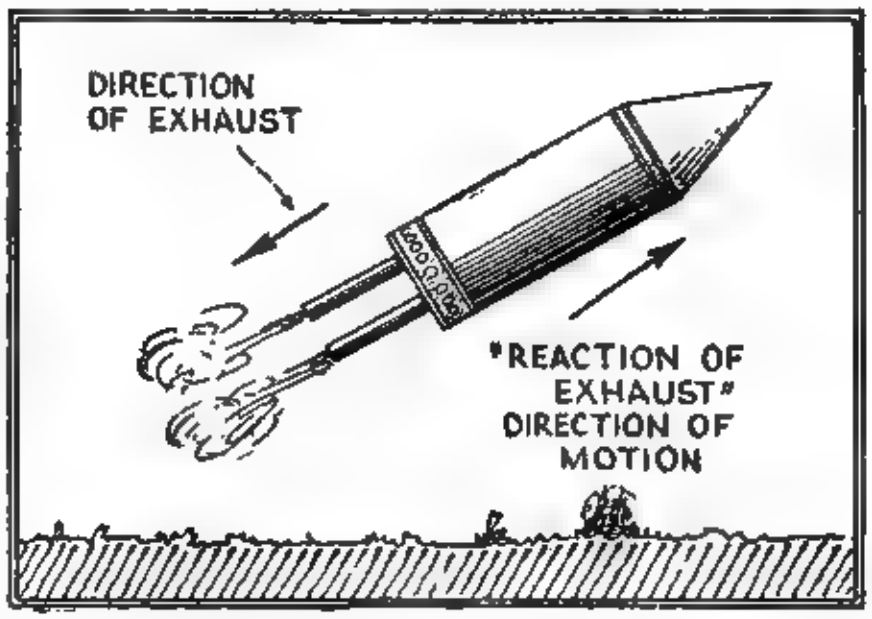
Editor Aviation Forum:

I have read the August and September issues of AIR WONDER STORIES, enjoying both very much. In each copy I found a story about flying machines insulated against gravity.

As the earth is revolving around the sun on its orbit, I think that the machine, not being attracted by the earth, would separate from this planet.

WALLACE FORBES,
Kansas City, Mo.

(This question is well taken. When a "gravity insulated plane" is spoken of it must be remembered that it is insulated from all gravity. The earth does not alone possess gravitational power, all bodies do. So when a body is insulated from all gravity it means that no body whatever (this means also no heavenly body) would attract it. Therefore if no other force acted, the plane would remain suspended in space. But the propelling forces of the craft are what drive it at any given direction. Freed from gravitational force the machines can move about as if no heavenly bodies whatever existed. And that is what happens in the case of the stories referred to. The only other possible force acting on the planes on the ground is centrifugal force. Now if a body on earth were freed of gravity suddenly and had no other motive power, it *would* suddenly fly off the earth at a tremendous speed due to the centrifugal force caused by the earth's motion. But in all the cases mentioned the planes rise into the air and are thus acting as free bodies—*Editor.*)



Showing the external operation of a rocket. The direction of motion is opposite to that of the motion of the expelled gases.

How Rocket Acts in Vacuum

Editor, Aviation Forum:

There has been a question that I have often wondered about. It must be very simple but I just can't figure it out.

As you know the reason for airplanes keeping in the air is that they beat the air with their propellers so as to force themselves. The elevator, rudder and other things govern its motion. The rocket plane works on almost the same order of pushing against the air to make it go up.

Outside of the earth's air there is only traces of gas and planets. The rest is ether.

Then how could a rocket plane move on its own accord if there is no air?

Another question is, wouldn't there be some gravity in space from the sun and planets?

EDMUND FITCH,
Chicago, Ill.

(The rocket is not propelled, as Mr. Fitch supposes, by pushing against the air but by the reaction to the exhaust of highly compressed gases. The action is like that of the recoil of a gun. Action being equal to reaction the force of the exhaust of the gases propels the rocket forward with the same force. Therefore air is not necessary for the rocket, in fact the rocket works best in a vacuum, as nothing impedes the exhaust of the gases. An airplane does not remain in the air by the action of the propellers but by the upward lift of air under the wings and the suction above the wings. The propeller drives it through the air. There is of course always some gravity in space from some heavenly body. But it is possible to reach points where the gravitation pull is so small that it is practically negligible.—*Editor.*)

(*Continued on Page 466*)

AVIATION FORUM

(Continued from Page 465)

Negative Angle of Incidence

Editor, Aviation Forum.

In the last issue of AIR WONDER STORIES there appeared a diagram explaining how the air pressure lifts the plane.

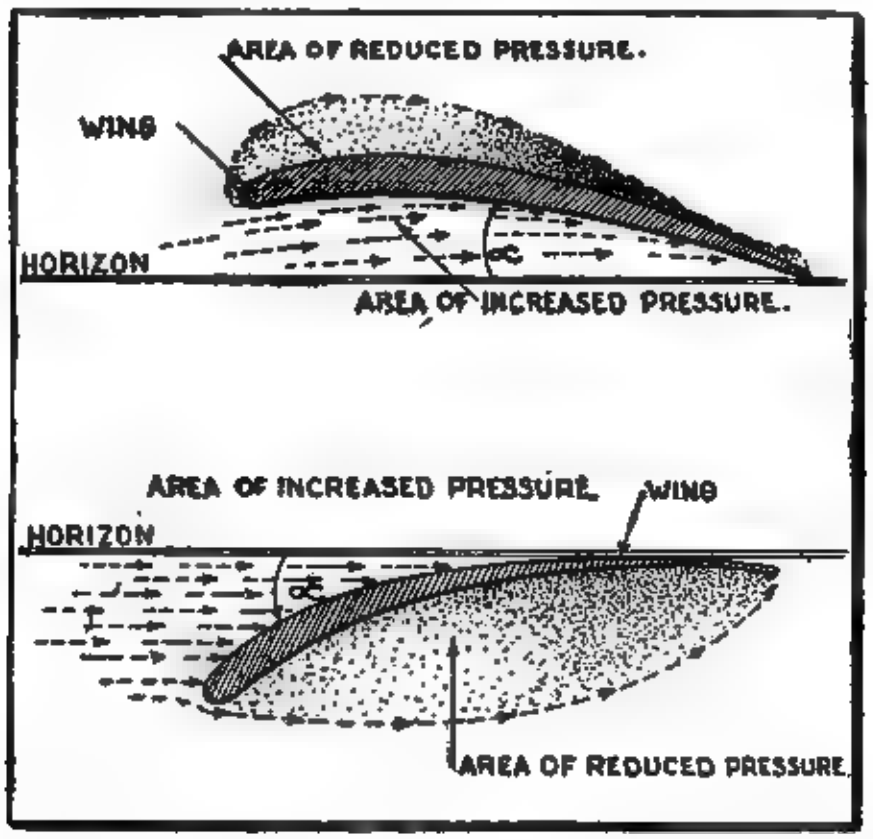
Now, I am generally interested in aviation, and personally interested to a very great extent in model building.

I have often seen the above-mentioned diagram and understand it fully. There is a point, however, that I always forget to look up, which often puzzles me, and I am jumping at this chance to have it cleared up.

Just how can that principle be applied, although I know it can, when the plane or wing is set at a *negative* angle of incidence?

WILLIAM BREKMEYER,
2345 V 16th Street.

(When a plane's wing is set at a negative angle of incidence [i.e., when the wing is dipped below the horizon] the same principle is applied as when it is above the horizon, but the effect is opposite. In other words, the wind striking the top part of the wing, in the case of a negative angle to the horizon, exerts a force tending to draw the plane toward the earth. Under the wing there is now a reduced pressure (as can be seen from the diagram) which tends further to depress the plane. The negative angle of incidence occurs, naturally, only when the plane is pointed toward the earth; there are no planes designed for operation with a negative angle of incidence —*Editor.*)



Illustrating the effect on a plane wing of a negative and a positive angle of incidence. As noted the negative angle occurs when the wing is dipped below the horizon. The positive angle is shown in the upper illustration and the negative angle in the lower.

About Radio-Controlled Planes

Editor, Aviation Forum:

Having read the first three copies of our magazine, I take the liberty of writing—and now to business—

"The Ark of the Covenant" is the best story I have ever read and I am a voracious reader. Your last chapter left them in an awkward position. I am due to speculate a lot till the next issue is out.

"The Air Terror" was good. The idea of filling the wings with a gas to help lift the plane looks feasible to me.

"The Yellow Air Peril" was also good. In building a ship with a tunnel through the center, would it not be possible to have quarters for the passengers inside also? I think the present gondola types would increase the resistance. Why pick on the poor Yellow Man or Bolshevik always? I think our own people who forever complain of their lot, curse incompetent public officials and thus foment trouble, yet refuse to vote, or assist in bettering their lot are our worst enemies.

"Men With Wings" may not have been good science but I have read it through four times and expect to read it still more as I keep all copies of this magazine.

Mr. Keller in "The Bloodless War" states that John Farrol tapped out a message and sent the planes out to sea. As I understand radio control the planes are controlled by a definite frequency or beat received aboard the plane by a sensitive receiver that moves the controls as the frequency is varied, perhaps I am in error, if so please correct me.

Finally—some writers are using Einstein's latest theory, to prove that gravity and electro-magnetism are one and the same. I understand Einstein said that gravity and electro-magnetism were *closely related*. Am I wrong? Sorry to take up so much of your time but you seem to invite it.

Arizona H. Duane,
c/o Ladolick Ranch,
Alma, Calif.

(Mr. Duane's conception of the method of radio control is quite correct. The sending and receiving sets are adjusted to the same wave length and frequency and by modulation of the frequency at the sending end the impulses transmitted are varied and various pieces of apparatus controlled by a certain frequency are operated.

Einstein in his latest theory stated that magnetism and gravity arose from the same fundamental cause. They are more than closely related, they are brother and sister, so to speak. And they not only operate in the same manner and by the same laws but also Einstein believes they can be controlled in the same way. For that reason our authors are quite justified in devising apparatus, which must ultimately come, by which gravity as well as magnetism can be shielded.—*Editor.*)

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AVIATION NEWS
General

(Continued from Page 464)

Warships to Be Helpless in Next War, Says Mitchell

GENERAL William Mitchell, former commander of the Air Forces, A.E.F. and Director of Military Aeronautics, U.S.A., writing in *Aeronautics*, states that in the next war, our naval fleet will be practically helpless against attacks from the air. Picturing a typical battle, he shows how a great fleet of planes operating from a convenient land base could overwhelm the aircraft of any naval fleet and then, at its leisure, proceed to sink the fleet. With the development of great high-explosive bombs, gas bombs, torpedoes guided by radio, etc., warships travelling at 25 miles an hour have no chance against aircraft travelling at 150 to 300 miles an hour. The Panama Canal, he states, is practically defenseless against attacks from the air, for, despite all that a naval fleet could do, a few well-laid bombs would make the Canal impassible. Considering the costs of a naval fleet and aircraft, he sees no reason for naval construction. Sixteen battleships costing about $100,000,000 each with all their accessory craft and equipment require an expenditure equal to that for a fleet of 60,000 airplanes, enough to overrun any nation.

Thinking Machine Aims Guns Automatically

TO combat the growing menace of airplanes in time of war, by increasing the effectiveness of anti-aircraft guns, the ordnance department of the U. S. Army has developed what is called a "thinking machine," says *Science News-Letter*. The device consists of two telescopes which are kept trained on the attacking plane by operators. One follows the horizontal and the other the vertical movement of the target. By means of gears these two movements are combined to give a resultant motion, and thereby a direction-setting which can be transmitted to the guns. Other operators, manipulating control dials, feed into the machine other necessary data; such as the range and altitude and corrections for wind and other atmospheric conditions. The instrument's setting is transferred to the guns by an electric cable. A synchronous motor mounted on each gun translates the instrument's data into movements of the gun carriage; whereby the muzzle of the piece is trained on the target, with enough "lead" so that a shell fired will arrive at a certain point at the same time that the plane does. A battery of high-angle guns can be operated by the machine with the assistance of a few highly-trained operators and the guns will be firing within thirty seconds after the range is determined. The cannoneers will not need to see the target, for they may be hidden in woods and separated from the machine by as much as half a mile. It is believed that several batteries of guns may be operated by one machine and thus a great concentration of artillery can warmly welcome any invading aircraft.

Pilots' Tests Harder in Europe

PHYSICAL examinations of prospective airplane pilots differ considerably in most European countries from those required in America. England has discarded the whirling-chair as a means of determining a pilot's equilibrium, and America has followed suit, adopting in its stead the English test; this consists of having the candidate stand on one foot, with the other leg bent at the knee, and eyes closed, for fifteen minutes. If this feat is performed satisfactorily, and the prospect has healthy ears and no disturbance of gait, he is considered to have a sufficient sense of equilibrium. Defects in this sense result in difficulty in keeping the plane on an even keel and cause the pilot to become confused in spirals, banks and spins. In France, the hearts and lungs of applicants are subjected to an X-ray examination, and they have also breath-holding and night-vision tests, which have either never been sanctioned in the United States or have been discarded. The eye test in this country differs from that of England, in that America employs a spotlight, red glass, Maddox rod and prisms; whereas England uses what is known as the 'red-green' test, in which red and green illumination is employed in a slotted form. Most of the European countries appear to be unwilling to issue licenses to women; and in England, France, Italy and Germany, transport-pilot licenses are refused to married women.

THE READER AIRS HIS VIEWS

IN this department we shall publish every month your opinions. After all, this is your magazine and it is edited for you. If we fall down on the choice of our stories, or if the editorial board slips up occasionally, it is up to you to voice your opinion. It makes no difference whether your letter is complimentary, critical, or whether it contains a good old-fashioned brick-bat.

All of your letters, as much as space will allow, will be published here for the benefit of all. Due to the large influx of mail, no communications to this department are answered individually unless 25c in stamps to cover time and postage is inclosed.

A Controversy: What Sustains a Plane?

Editor, AIR WONDER STORIES

AIR WONDER STORIES for September favored me with a real "wonder" indeed, namely, Major William A. Bevan's letter, printed at the bottom of page 283, explaining the wing lift on airplanes. Inasmuch as this is based upon a transparent fallacy which is eradicated from the mind of every high-school student during his first year's study of physics—I mean the popular idea that a vacuum has any "sucking" or "lifting" power whatsoever. Water follows a pump plunger, not because the vacuum itself has any power to *lift*, but because of the difference of pressure on the surface of the water under the plunger and the outside surface exposed to the atmosphere. The lift on airplane wings is *entirely* due to the air pressure on the lower side of the wing, and this pressure is composed of two factors: the dynamic pressure of the flowing air, and the static atmospheric pressure exerted, due to the vacuum on the upper side. The impossibility of a vacuum *lifting* anything can be readily seen by simply asking the question, "as to what material exists as a vacuum capable of exerting a suction force?"

I do not have the August number at hand, and so cannot pass on the correctness of the reply given by you and to which Major Bevan takes exception. The whole matter is quite surprising because, although laymen and novices frequently still make the statement that the lift on airplane wings is caused by a vacuum, this is the first time I have seen it sponsored by a Professor.

In another connection, Mr. Wallace C. Wardner's letter, printed on page 282, is equally in error. Mitchell's famous propaganda is now three or four years old, and entirely inapplicable to present conditions. As the facts appear to me, it was considerably overdrawn, owing to the distortion of perspective which every enthusiastic professional mind acquires in regard to his own specialty in the course of time. Had Mitchell's agitation succeeded, the United States would now have been saddled with many million dollars' worth of obsolete planes, utterly useless in the case of air attack; inasmuch as any military plane more than one or two years old is superannuated. At the present time, the United States is tremendously superior to any other country, not merely in the number of up-to-date planes, civil and military, now in commission, but in factory facilities for turning them out. Had a tremendous investment been put into planes at the time of Mitchell's agitation, it would now have been lost; and the process, to carry out the idea logically, would have to be repeated at least every two or three years, imposing an intolerable burden upon the taxpayers, until such time as their patience gave way.

Hart Vincent's story, "The Yellow Air-Peril," I regard as extremely objectionable. If a scientific publication is to enter at all into religious and racial matters, it should be along such lines as will help to eliminate ignorance, prejudice, and misunderstanding of alien peoples and alien faiths. As one extremely familiar with the teachings and spirit of Buddhism and Buddhists, I wish to state that the aims and ambitions ascribed to the "Guardians" in the story, represent very accurately the spirit of the "Christian" nations. They are nothing short of libelous and slanderous as applied to the doctrine whose restraining influence upon the Asiatic hordes, in the early days, made the development of Western civilization possible. Otherwise it would have been wiped out in its infancy. I regard this article and Wardner's letter as typical demonstrations of the deficiencies of the scientific mind in regard to accomplishing the object which is absolutely essential to the future salvation of civilization, namely, the bringing about of a spirit of inter-racial and inter-religious understanding and brotherhood.

Victor A. Endersby,
Associate Bridge Engineer,
California Division of Highways
Sacramento, Calif.

(Inasmuch as Mr. Endersby's chief criticism was directed against Major Bevan we asked the latter to write an answer to this letter. We print Major Bevan's letter without comment.—*Editor.*)

Editor, AIR WONDER STORIES:

I will say that this party is merely quibbling over a word. I had no intention whatsoever to convey the idea that a vacuum has in itself any "sucking" or "lifting" power. Nor is there in my statement any fallacy that is supposed to be "eradicated from the mind of every high-school student during his first year's study of physics." I used the term "vacuum" in its commonly accepted sense and as used by all engineers; namely, a reduction of pressure. We have on steam condensers "vacuum gauges" that are marked and calibrated to read "vacuum in pounds" or in "inches of mercury." We use manometers to read reduction of pressure below that of atmospheric and, again, speak of it as a "vacuum of so many inches of water" or "of mercury" as the case may be. It is not incorrect for "laymen," or "novices," or even engineers to use the word "vacuum" as I have used it, regardless of how much it may "surprise" this critic.

It can be readily shown that there is a reduction of pressure or "partial vacuum" on the top side of a wing when either the wing is drawn through the air or air is blown or drawn by the wing. Static tubes placed flush with the surface of the wing and connected to some measuring device or manometer readily show the distribution of pressure on the surface of a wing. It is the reduction of pressure, or "partial vacuum," on the top side of the wing, that causes the static pressure on the bottom side of the wing to be effective in giving lift. If the pressure on the top and bottom sides were the same, then there could be no lift due to static pressure on the bottom side. When flying one can readily see the bulging upward of the fabric between the ribs and the spars on the top side of the lower wing. This is especially so in the path of the propeller-slip stream. Of course, the same thing is true of the fabric on the top side of the upper wing.

It is considered that the decrease in pressure, or "partial vacuum," on the top side of a wing is due to an increase of velocity of the air on the top side above that on the bottom side. Bernoulli's Theorem states that there is a reduction of pressure when the velocity of the fluid is increased.

After objecting to my use of the word "vacuum," you will note, this critical person in his explanation of the lift on a wing makes the statement that the "static atmospheric pressure exerted" on the lower side of the wing is "*due to the vacuum on the upper side.*" In other words, he uses the word "vacuum" in exactly the same manner that I used it in my article in the September issue. However, he tries to make out that my statement was entirely incorrect.

For a more complete discussion, than I have the time or the space to give on the subject, of the "lift on a wing," I would suggest that this critic read Chapter III of Warner's *Airplane Design (Aerodynamics)*. There he will also find a brief discussion of the theory of lift as developed by Kutta and Joukowski.

Most persons, whom this critic calls "laymen" and "novices," think that the "lift on a wing" is due entirely to the dynamic force of the air on the under side of the wing. It was to correct that idea, that I wrote my brief note as published in the September issue of AIR WONDER STORIES. I merely wanted to bring out the fact that only a small part of the "lift" on a wing is due to dynamic pressure and that most of the "lift" is due to a reduction of pressure on the top side. I did not go into detail as to why this was so or why, therefore, the static pressure of the air on the lower side would then be effective.

Furthermore, there is nothing in Mr. Wardner's letter to call for the above criticism. General Mitchell's claim that the United States had an inadequate air force was perfectly true three or four years ago, and is still true today. I have been an officer of the Air Service and the Air Corps, Regular Army and Reserve, for twelve years, and I know what I am talking about. This critic's statement that "At the present time, the United States is tremendously superior to any other country, not merely in up-to-date planes, civil and military, now in commission, but in factory facilities for turning them out" is one should to call for much comment. He evidently knows nothing whatever about the aviation, civil and military, of Great Britain, France, Italy and Japan; and, especially, the civil aviation of Germany.

William A. Bevan,
Professor of Aeronautical Engineering,
Iowa State College,
Ames, Iowa.

When Is a Tail Spin?

Editor, AIR WONDER STORIES

I have just finished reading the third number of AIR WONDER STORIES and think it the best air magazine anywhere. The "Ark of the Covenant" was a pip! I also liked the "Yellow Air-Peril" very much. But as for "Where Gravity Ends"—don't you think that was just a little far-fetched? There were a few minor errors also. Mr. Lindfred said that, when Merrill eased down on the throttle, the plane got into a spin. A plane will not fall into a spin if the controls are in neutral. If a model stalls, it never spins because the controls are in neutral. It either slips off and dives, or the nose drops in a whip-stall and it dives. A plane is brought *out* of a spin by bringing the controls to neutral and diving until flying speed is attained. Even if it did fall into a spin, it could not be brought out by gunning up the motor. Also it would not commence up when it was brought out.

Merrill thought that perhaps he was being blown by a great tail-wind when the motor read 300 M.P.H. If he were blown by a wind he could not tell by the motor that he was going that fast; because the wind prop that works the motor would not travel that fast with a tail-wind. The plane might have that much ground speed, but the motor cannot show that.

That is all I can find wrong with the whole magazine.

Harrison Stephens,
621 No. Las Palmas,
Los Angeles, Cal.

(Mr. Stephens should remember that the plane in question was headed upward when the motor turned down the throttle. It would seem then that the only thing that could happen would be a tail spin. What Mr. Harrison returns would indeed occur if the plane were travelling on an even keel at the time the pilot eased down the throttle. But a plane headed upward would not be apt to go into a nose dive. We appreciate, anyway, his criticism.—*Editor.*)

(Continued on Page 480)

THE READER AIRS HIS VIEWS

(Continued from Page 467)

"Beyond Gravity" a Disgrace?

Editor, AIR WONDER STORIES:

I am an enthusiastic reader of both Air Wonder Stories and Science Wonder Stories. I have just read the September issue of the former, and enjoyed it immensely, but I would like to offer my criticism which I hope you will take in the spirit in which it is given.

I find that almost all of the stories are scientifically well-founded, but the great trouble is that there are very few men with great literary ability combined with a broad scientific knowledge. For example, as far as literature goes, "Beyond Gravity," in the August issue, was a disgrace to the name of story. Its science was O.K.; but I assure you I have read better stories from the pens of grade-school children. The idea of a man's falling in love with a girl, like he did, is absolutely ridiculous. Mr. Repp seemed to imply that their engagement was a sure thing from the first. My advice to authors who cannot do any better than that is to stick to science and leave love-making to someone who can handle it.

"The Ark of the Covenant," by Victor MacClure, is a corker. If more stories could be like it I would have no complaint, but I realize how hard it must be for you to find authors like Mr. MacClure. I suggest that if you cannot find more like him, you enlarge upon your "Aviation News of the Month" department, and have more practical articles like the one on "The Airplane of the Future." That alone was worth the price of the magazine, and one or two like it every month would put your magazine on a much higher level.

Why don't you have a story contest and uncover some new talent (which I am sure you would) rather than publish some of the punk stuff I have referred to?

Courtney R. Draper,
352 So. 21th Street,
Salt Lake City, Utah.

(We are not sure whether Mr. Draper objects chiefly to Mr. Repp's method of portraying a courtship, or whether to his literary style also. If it is the former, we must rise in Mr. Repp's defence to state that with the collapse of Victorianism, love-making has undergone a complete change. There is no definite method or formula that one can rely on, and Mr. Repp merely wanted to illustrate one method. Personally we enjoyed it.

The story contest has already been started. Mr. Draper will find it in the November issue of Science Wonder Stories, where it is being worked out in a very novel manner. We expect great things from it.—*Editor.*)

The Energy Within the Atom?

Editor, Air Wonder Stories.

As I make my debut as a critic I must say that your magazine (mine also, now) is the best of the old and new aviation magazines now on the stands. Up to the present, I have derived much entertainment and, I believe, some education, from the stories. I do not deplore the "impossible" stories; as some of your other readers "pretend" to because they cannot grasp the new theories brought up. In fact there are many theories I am not able to take in but that does not spoil my enjoyment of these stories written so interestingly with soaring imaginations. When I say that I cannot grasp or take in a far-reaching new idea, I mean that it is not possible for me to "picture" its form although I may understand and appreciate its possibilities. Take the condition of weightlessness for example; my mind is not able to think long about this without beginning to topple.

Once I thought that only trouble-makers complained about minor mistakes; such as a sentence construction, where an entirely different construction appears in the midst of a story at an interesting point, upsetting the entire meaning. Now, however, I join the ranks of, not the "trouble makers" as I once called them, but the ranks of the constructive critics as I now call them. Minor flaws show me that the author of the story in which they appear (the flaws) is not a particularly good writer. But the real reason I do not like these errors, (I have been evading a good deal, haven't I?) is that they jar upon my senses and thus curtail my immediate enjoyment and appreciation of the story.

The "Aviation News" department is a great idea. Although one or two articles appearing may be old, the *new* news of aviation's progress compensates quite capably for it and overshadows it overwhelmingly. I would rather get all this information from this one magnificent aviation science-fiction magazine than from forty non-fiction and most likely dry and drab scientific journals—as one of your readers has written you that we, the other readers should do.

I think that the "Aviation Forum" is another good means of establishing favor among us readers. Just the same I think that this department is incompetent. I'd bet that these two questions, though simple in appearance and of great interest to all of your followers, cannot be answered in the columns of the "Aviation Forum."

How is an airplane controlled during soaring and in the air?

How does an airplane motor function?

Now I've changed my mind; I think that these questions can be answered but not completely enough to satisfy my lack of knowledge on this subject. If all your readers saw this there would soon reach your files some one's written opinion corresponding to and meaning, something like this "Enough is enough, this guy wants too much." Isn't it so? (This is meant as a compliment, and nothing else.)

The book reviews are quite good but I am not much interested in them and I would not be heartbroken if they were omitted in order to have more space for the "Aviation Forum."

(Continued on Page 471)

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(From The *Illinois Motorist*)

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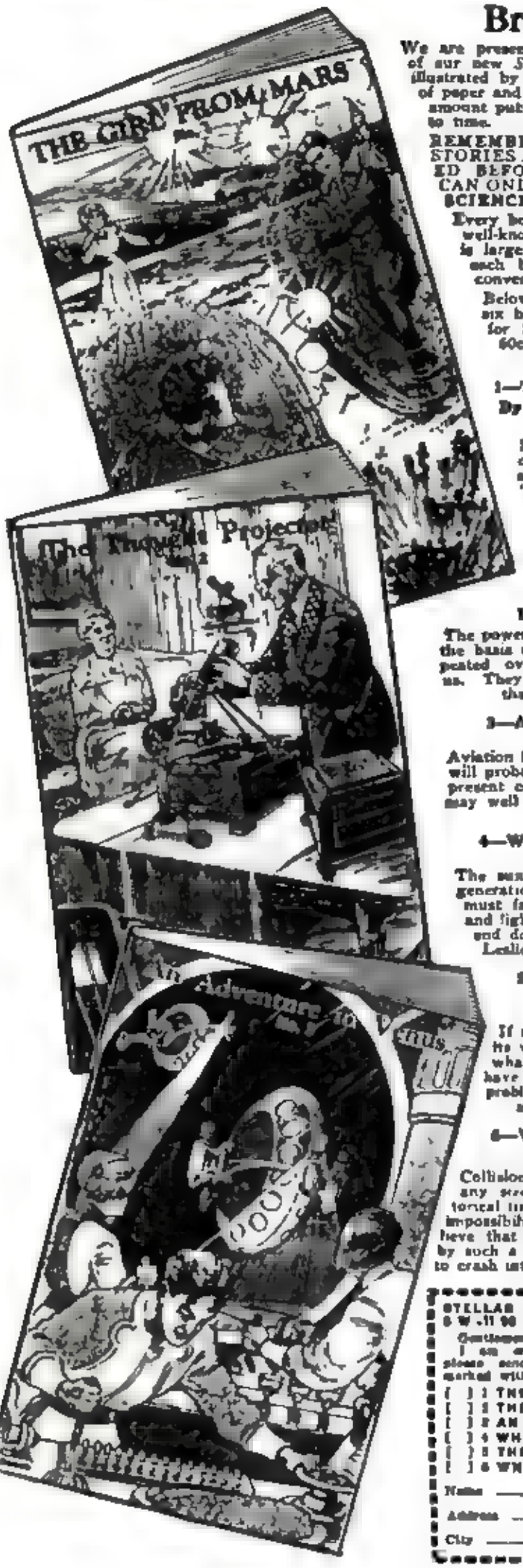

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THE READER AIRS HIS VIEWS

(Continued from Page 468)

Please do not fold the magazine when you send me the succeeding issues, the binding and the pages are ruined and the cover is almost completely beat and torn when the magazine reaches me. I should also like you to refrain from folding the magazines SCIENCE WONDER STORIES and SCIENCE WONDER QUARTERLY to which I have recently subscribed.

(This has already been rectified.—Editor.)

There is one thing that I do not like to see in any magazine and which appears in AIR WONDER STORIES, that is, serials of more than two parts. The reason for this is clear. In one month many things are forgotten including the first or second part of a serial, therefore I save the several parts of each serial until the whole is obtained. To wait a month to put a story together is a long time, two months are interminable; and more than that is without expression.

The kinds of stories I should like to find in *Air Wonder Stories* are:

1. Interplanetary Stories.
2. New Fads in Present-Day Aviation.
3. Air Mystery Stories.
4. Humorous *Air* Stories of the Future.
5. Humorous Mystery Air Stories.

I shall now proceed to give a short criticism of the stories printed up to now.

Islands in the Air—Excellent. But I thought that the islands were neutralized against gravity with the aid of a machine on the ground. How did the remaining island fly off into space lost forever?

The Beacon of Airport Seven—Quick action on a new theory. The story was greatly appreciated.

The Bloodless War—Well-written and I enjoyed it. But why would the United States be so unprepared for aerial war and unwilling to listen to reason at first? But of course that lent space to the story.

Men With Wings—An example of excellence and nothing else but, in all its aspects.

The Silent Destroyer—A very, very good science—aviation—fiction story that I liked very much.

Beyond Gravity—A marvelous story in a marvelous magazine.

The Planet's Air Master—The best story of them all.

The Airplane of the Future—I appreciated this article in such a magazine.

The Yellow Air Peril—Ah, marvel of marvels. This author cannot be downed. I must bow down to his greatness. The story is unsurpassed.

Where Gravity Ends—Excellent for its size. A baby grand.

Flight in 1999—This story is as good as advertised. I liked its new ideas, while with its underlying humor it became topping.

One conclusion I think all your authors and many scientists have got wrong is the atomic engine; not in the form of the engine but in the theory itself. I think that the energy in an atom is not sufficient to move a grain of sand—hardly a large machine moving and controlling a gigantic airship or landship. My theory is this: an atom has a great amount of energy but that energy can only be dissipated through an infinitely small space. In a hydraulic press there are two pistons; one small and one large piston. The small piston is pushed down to operate the press. When this is done, the pressure exerted on the large piston by the water is as many times greater, as the area of the large piston is greater than that of the small piston. However, the large piston is only moved a distance equal to the volume of the small piston in cubic units divided by the area of the large piston.

If in a hydraulic press the area of the small piston is 50 sq. in., the area of the large piston is 1,000 sq. in., the volume of the small piston is 1500 cu. in. and a pressure of 100 lbs. is exerted on the small piston, what pressure is exerted on the large piston by the water in the press, and how far will the large piston move in one movement?

As the pressure on the large piston is determined by multiplying the pressure exerted on the small piston by the amount of times the area of the large piston is greater than the area of the small piston, and the area of the large piston is 1000 sq. in., and the area of the small piston is 50 sq. in., then the pressure on the large piston is 1000 ÷ 50 × 100 thus equalling 2000 lbs.

But since the distance the large piston will be moved is determined by dividing the volume of the small piston by the area of the surface of the large piston being acted upon by the water, and the volume of the small piston being 1500 cu. in., and the area of the pressure surface of the large piston being 1000 sq. in., then the distance it will move will be 1500 ÷ 1000 or 1.5 in.

Now suppose it possible for the small piston to be the size of an atom which has, let us say for convenience, one two-millionth of one inch as length, width, and depth respectively. The large piston will be the size of an imaginary piston of an imaginary atomic engine, say about 60 square inches area on the pressure surface. If the small piston representing an atom had a force of 1,000,000 pounds exerted upon it (in an atom by the movement of its electrons) and in one minute as to develop 50,000 horsepower (or since one horsepower is 33,000 foot-pounds per minute, it is to develop an amount of power of 50,000 × 33,000 or 1,650,000,000 foot-pounds per minute) the requirement of power in an atomic engine that would drive a gigantic airliner of the future, would this power be developed?

Even for an atomic engine requiring only 5 horsepower there would be needed at least 2,400,000,000 atoms.

Therefore it is my final conclusion: That it is not possible or practical to run so-called atomic engines by isolating the atom and so therefore it is equally impossible and impractical to run any other type of engine by this method. That because of the inability to use this method the only solution is to increase the efficiency of machines to a very high degree and to obtain fuel for these machines by transmutation of the atoms of valueless materials into fuel. (I believe that transmutation of the atom will come about.)

In closing this long and interesting ? ? ? letter I wish to say that I won't mind if your authors keep on using the atomic engine in their stories and I want you to keep up the good work getting better and better with each successive issue and if possible I should like you to publish this letter in "THE READER AIRS HIS VIEWS" so that my astounding (?) revelations about the atomic engine might be read by all to be criticised and corrected if I am wrong in my statements on this subject.

Edward Sheinberg.
Arverne, L. I.,
New York.

(We were very much interested to get Mr. Sheinberg's ingenious development of the "energy within the atom" question. But Mr. Sheinberg approaches the question from the wrong end when he seeks to discover the "pressure" that an atom would exert against a piston.

The energy within the atom is purely the kinetic energy of the electrons revolving about their nuclei. The velocity, for the sake of computation, may be assumed to be 100,000 miles per second or 528,000,000 feet per second. Now if it were possible to utilize that kinetic energy by turning it into another form (as the kinetic energy of the particles of steam is used to rotate turbine blades) we would have the energy expressed by the equation $E = MV^2/2$ where V is the velocity and M is the mass of electrons. Let it be assumed that we have one pound weight of electrons to give up their energy.

The energy in foot pounds in a pound of our electrons would be 0.50 × 528,000,000 × 528,000,000 or 139,392,000,000,000,000 foot pounds. This is enough energy to raise the 60,000 ton *Leviathan* 1,161,600,000 feet or 220,000 miles, nearly the distance to the moon. It can be readily perceived therefore that the statement that a thimbleful of water could drive an airship is no exaggeration. We would be very glad to get the comments of our readers on this most interesting question.

Finally Mr. Sheinberg in his own manner really has proved the case of the energy within the atom. He says that 2,400,000,000 atoms would be required to give five horsepower to an engine. Now the volume of 2,400,000,000 atoms is so infinitesimal that it could not be seen by a microscope. There are 85,000,000,000,000,000,000,000 atoms of copper in one cubic centimeter. So, according to Mr. Sheinberg's conclusion, one cubic centimeter of copper could furnish about 40,000,000,000,000 horsepower. Quite a respectable amount of power.—*Editor.*)

(Continued on Page 473)

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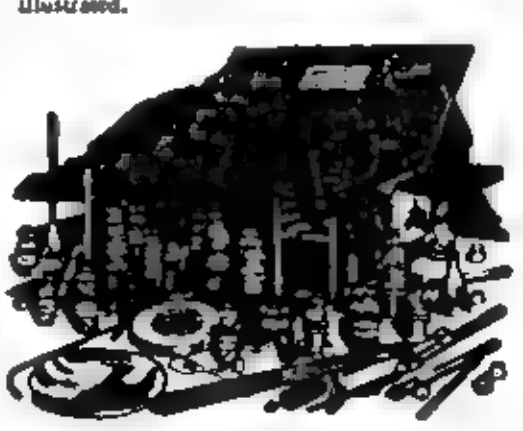

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THE READER AIRS HIS VIEWS

(Continued from Page 471)

Could Not Blow That Far

Editor, Air Wonder Stories:

I have received the September issue of AIR WONDER STORIES and read it through. In the comments on "The Reader Airs his Views" you said that you missed the familiar brickbat. Well, here goes.

In the first place, the paper is too thick. It makes the magazine too thick and unwieldly, and it tears too easily at the staples. Also, you should use more staples, the magazine comes apart too readily as it is. Again please print the full addresses of the contributors to "The Reader Airs his Views" and "The Reader Speaks." The August issue of SCIENCE WONDER STORIES contained a letter describing a Science Correspondence Club, but Mr. Malotte's address was not given in full. How can anyone who is interested in the club get in touch with it? And you said you would do all in your power to help the club. One more: The wrapping of the magazine is too flimsy.

That will do for the make-up of the magazine for the present. Most of the stories were good, with a few minor exceptions. "The Ark of the Covenant" was by far the best. I have never read a better story of the air and never expect to. "Flight in 1999" was also fine. Mr. Morrow's second attempt was better than the first.

"Men With Wings" was a well-written story; but there is some doubt as to whether the human organism could uphold the skeletal and muscular structure necessary for wings without grave changes. However, what is important in a story is the story itself.

In "Beyond Gravity" a ship with rocket propulsion is caught out in space beyond the earth's gravitational field. Why didn't they use the rocket tubes to come back? No up-wind could blow them that far, anyway.

I hope that you will accept these comments with the good feeling with which I write them, and keep on publishing a bigger and better magazine.

Clyde F. Beck,
Box 486,
Lakeport, California.

(What Mr. Repp meant by "Beyond Gravity" was not literally that the *Annihilator* was taken beyond the earth's gravitational influence for many thousands of miles would have to be traversed into space before such a thing could occur. What he did mean was that the up-draft was so powerful that it more than overcame the force of gravity. Such a thing occurs when a tornado lifts up trees, houses, automobiles and cattle. The only difference is that the up-draft constituted a permanent force, whereas a tornado after it has passed over an area allows the bodies to fall back to earth. Raymond A. Palmer is secretary of the Science Correspondence Club. His address is 2226 Vine St., Milwaukee, Wis.—*Editor.*)

(Continued on Page 474)

IF you have not as yet seen the SCIENCE WONDER QUARTERLY,

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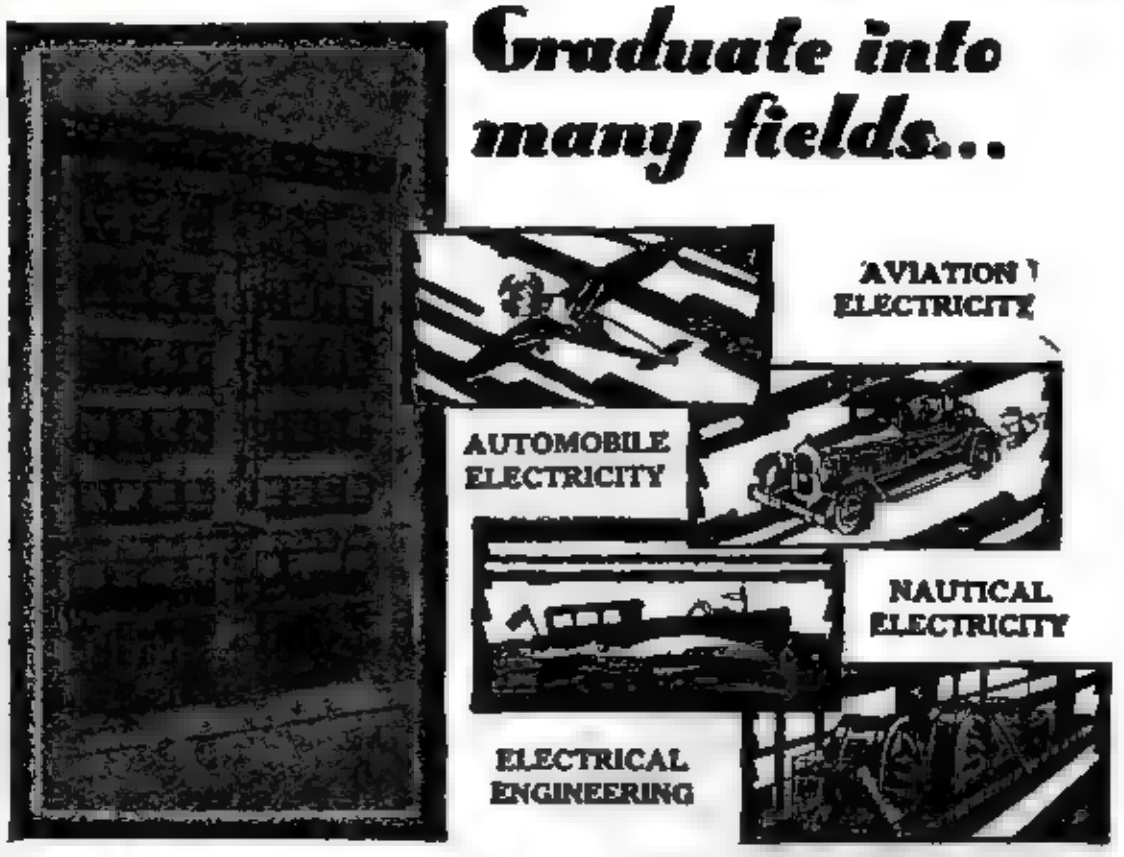

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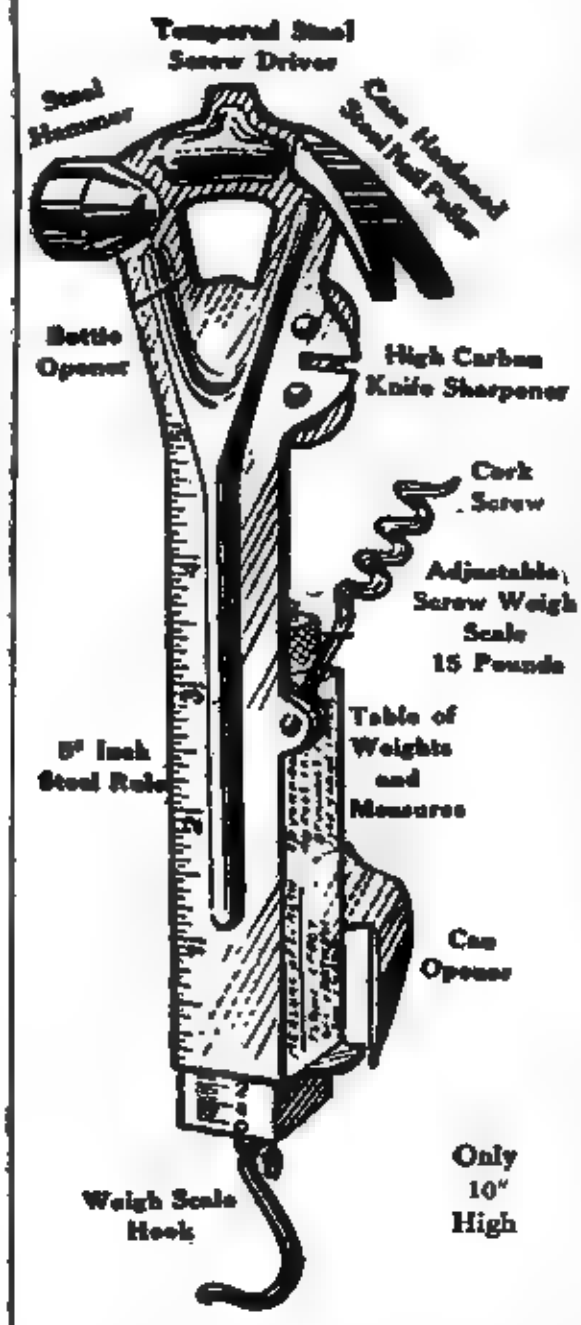

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AIR WONDER STORIES

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THE READER AIRS HIS VIEWS

(*Continued from Page 473*)

A Reader's Correspondence Page

Editor, Air Wonder Stories:

Congratulations—mainly because every issue seems to be outdoing its predecessor. I am interested, not only in the fine stories that are being published, but also in the readers' ideas on them.

In looking over the comments in the September issue, I noticed a great deal of comment over "Men With Wings." I will say that it is one of the finest stories of its type that I have ever read. The feature of its being written by a young woman only increases my admiration.

"The Ark of the Covenant" is another fine story and deserves to rank with the leaders. What could you expect from Victor MacClure?

I think the stories of this issue should be ranked as follows: "The Air Terror," "The Yellow Air Peril," "Where Gravity Ends," and lastly "Flight in 1999." For some reason or other the last did not appeal to me. The plot did not seem well knit. The ideas were splendid and I think a much more interesting story could have been built around them. Of course, that is my idea.

Now come a few thoughts suggested by my fertile imagination. Why not have a page whereby readers might be able to correspond with each other? Although Air Wonder Stories is a growing magazine everyone is not air-minded and I should like to correspond with some fellows about sixteen who have their own ideas on these stories.

Here comes a new thought. It may have already been expressed. I have always been an ardent admirer of stories from the pen of Edgar Rice Burroughs. Nothing would please me more than an aviation story of the future by him. His Martian stories show that he would have no trouble at all in penning a rousing story for our magazine.

Here's looking forward to the same high grade stories and an Air Wonder Quarterly.

Norman E. Matheson,
Frankford, Pa.

(We have received requests for so many new departments for our magazines that we must go slowly. We are however very glad to get this suggestion. The request for stories from the pen of Edgar Rice Burroughs is also under consideration.—*Editor.*)

Fact and Fiction

Editor, Air Wonder Stories.

Reading your criticism of my letter published in the September issue, I find your complaint as to receiving letters with nothing but praise in them for Air Wonder Stories. But Mr. Gernsback—what can a fellow do? I admit that you receive brickbats from indignant writers, but I am neither a misanthrope nor a halfwit. No allusions to the carnes of brickbats, BUT!

I got a hearty laugh out of the flying figures on the September cover, illustrating "Flight in 1999." You see, all of them had their arms extended in a peculiarly laughable manner, and I was reminded of a friend of mine who broke an arm and had it in a cast over his head. Everybody he looked at waved back at him.

I was afraid that you would crowd out stories with new departments; but this you have not done, in spite of Jack Darrow's remarks.

"Where Gravity Ends" left me in a peculiarly helpless and bemused condition. I couldn't understand it. Did it, or was it, or has it happened? About the only way I can tell a fiction story from a true article is to read the first paragraph. You see, I'll find, "Although this story may sound incredible, I beg you to believe that it is solemn truth, and for God's sake take action on it and rescue me" and so on and so on; and at last "to be continued in our next." That's fiction, in case you don't know it.

Oh, Bob Olsen. You have broken my heart I mean with that story, "Flight in 1999." I don't know why, but I didn't like it. In fact, I disagreed with me intensely. I would rather read one of your fourth-dimensional stories any day. Take the hint. Only one thing for Morrow He is GOOD.

When I first read Air Wonder Stories, it affected me so much that I wrote a comic aviation story about a rocket-plane. The usual thing

(*Continued on Page 475*)

THE READER AIRS HIS VIEWS

(Continued from Page 474)

occurred. One of my friends (?) told me that it was the greatest tragedy of a generation. And if I'd written a tragedy they'd have rocked with laughter.

So I read 'em instead.

I'm not the only one who made that mistake about Leslie Stone. And for that matter, I don't expect this letter to find you alive. For one Fred Pearson asked for Leslie's age and *you told him!* Whether it was right or not don't matter, as no man can safely tell the age of a member of the opposite sex. Have you forgotten what our old friend, Dr. Hackensaw, remarked to Pop, "There are two things it doesn't pay to monkey with; one is a buzz-saw and the other is a woman's age." I hope Leslie doesn't live in New York; and anyway, look out for infernal machines. I'm not giving my address for the same reason.

When I found the Sept. issue of "our magazine" on a newsstand it was upside down. Perhaps that affected the same plate causing it to go into a side slip? Kindly advise.

Henry Kuttner, Jr.,
Los Angeles, Calif.

(We are always glad to get letters from Mr. Kuttner. They are alive, witty and charming. As he will notice a great many letters appearing in the present issue begin by remarking that we asked for "brick-bats" and now we are getting them.

So the request we made in answering Mr. Kuttner's letter was successful after all.

We felt that airplanes do not always fly on an "even keel." In fact they are always at an angle when banking and making a turn. Air Wonder Stories are always making a turn [for the better].

"Where Gravity Ends" is one of those powerful little bits of fiction that are written so realistically that they do convey the idea of reality. The "newspaper clipping" of course was only to give the verisimilitude necessary.—*Editor.*)

IF you enjoy AIR WONDER STORIES, you must read of SCIENCE WONDER STORIES, its sister magazine. In SCIENCE WONDER STORIES you will find all of the good authors who write for AIR WONDER STORIES, and there are many stories that deal with aviation and, particularly, space flying and interplanetarian trips. Be sure to get the November issue now on all newsstands and read about the $300 short, SHORT Story Contest which you can enter. Table of contents follows:

"The Phantom Televiser," by Bob Olsen
"The Efficy Flash," by Hugo Gernsback
"The Gold Triumvirate," by Walter Kateley
"The Human Termites," by D. H. Keller, M.D.
"The Green Intelligence," by Harley S. Aldinger
"The Stellar Missile, by Ed. Earl Repp

The Airplane of the Future

Editor, Air Wonder Stories

The first "brickbat" I shall throw will be at you. In your editorial you stress the point that rocket engines will be the future means of propulsion used by airplanes, and then on the next page you give a description of the airplane of the future, and never mention the rocket.

The "Aviation Forum" meets with my hearty approval. It will probably settle many arguments between "would be" aviators, and answer many questions for the benefit of all readers of Air Wonder Stories.

The "Aviation News of the Month" is a very useful department. Although there are times when an item which appears under that heading may be known to some, the majority of them are news.

Victor MacClure's "Ark of the Covenant" is by far the best science air-fiction story which has appeared in this magazine, and is one of the best stories I have ever read.

Bob Olsen sure gives one a very good idea of what life in 1999 will probably be like. It may not be too absurd to hope that some of us will live to see in reality the scenes pictured in his story.

I see Lowell Howard Morrow is back with us again. His story "Islands in the Air" was very good, but "The Air Terror" is still very much better.

All the other stories published in this magazine are good, but there is not enough room and time to discuss each one.

The aviation questionnaire will be much better if you will also print the answers.

Paul is surely turning out some wonderful cover illustrations lately.

Thomas Morris,
Lansing, Mich.

(Mr. Morris should remember that the future includes a long time. Although we do believe that in the long run the rocket plane will be the ultimate type, still the development of the propeller plane is going on and planes such as were pictured in the "Airplane of the Future" will undoubtedly be built. It has frequently been true that two types of machines, of all kinds, have been developed side by side for a long time before one type finally superseded the other.—*Editor.*)

Fiction Alone Is Silly

Editor, Air Wonder Stories:

I have been reading with interest your September Air Wonder Stories. I surely admire MacClure, for his wonderful detail and technic in this month's "Ark."

Some of his points are fine, but his plan of steering a gas cloud, ionized with a high-tension current, is sure going some.

I fail to agree with Mr. Darrow of Chicago with regard to the "Aviation Forum," and "News." Fiction unless backed by some sense and reason, is silly and worthless, as well as pernicious.

W. H. Plumley,
Kansas City, Mo.

(We do not agree with Mr. Plumley entirely that fiction must always be backed by non-fiction material to make it worth while. But in the case of science fiction, where the aim is to educate and stimulate as well as entertain, we will say unqualifiedly that any informative material added to the fiction pages helps to carry out the magazine's purpose. This view is in accord with that of the majority of our readers.—*Editor.*)

From an Eleven Year Old Girl

Editor, Air Wonder Stories:

Whew what a book! A few nights ago I bought my first copy. That night I got quite a few thrills. The stories are wonderful.

"The Ark of the Covenant," I enjoyed

"The Air Terror," by Lowell Howard Morrow, "Flight in 1999," by Bob Olsen, I think were best. Please have some more stories like them.

I was disappointed in the "Air Terror" that the hero didn't marry Miss Brandon

The "Yellow Air Peril," I thought was thrilling

I think I could repeat the "Air Terror," "Flight in 1999," and "Where Gravity Ends," by heart.

When I go to college I am going to take science as one of my studies. I think it very interesting. I don't know a thing about an airplane, but would like to learn.

Why do the good men in stories either get stabbed, shot, poked with a bloody poker or disappear, when some one shouts something at them?

I really didn't see why the Captain or Borden had to get killed in the "Yellow Air Peril."

I'll have to wait a whole month before I can get another "Air Wonder" book.

It's terribly hard to wait

Couldn't you have some more Science magazines put on the market? I would be one of the willing buyers. Please do.

Please answer this question. Why do you want criticisms when you can always get compliments?

Why in the world don't you have more stories in it? They're entirely too few, and too short.

Also! Please try and see if the author of "Where Gravity Ends," won't write a sequel.

Mary Cameron Bassett
Dallas, Texas

(This is quite an interesting letter to get from a young girl who, we, believe is only 11 years old. It betrays an unusual interest in sci-

(Continued on Page 476)

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THE READER AIRS HIS VIEWS

(Continued from Page 475)

ence and gives us hope that in the future, as many science fiction authors have indicated, women as well as men will produce our scientific marvels. We recommend to Miss Bassett a study of the life of Madame Curie who discovered the properties of radium. It will be quite inspirational.

It is too bad that men must be killed in battle and that heroes cannot marry heroines. But unfortunately "that's the way life is."

If we desist from putting out more magazines it's only because of the pleas of our readers. They tell us that if we do publish more they will have to buy them and it will keep them broke. However every now and then we will publish more science fiction books such as the six books now available so that those who want them may have them.

It is only wisdom on our part that causes us to ask for criticism. There is nothing so destructive to editorial morale as a "swelled head." We must have our readers watching us carefully and writing us our misdeeds so that we may always be kept alert and watchful.

We invite Miss Bassett to write us anytime the mood seizes her. And, perhaps, some day she can be induced to write us a good "letcher."—*Editor.*)

Adventure Necessary to Science Fiction

Editor, Air Wonder Stories:

Not wishing to mutilate my magazine, I am writing criticism below.

Cover—Excellent drawing, but subject is rather ill-chosen.

Table of Contents—Too much "near month" and not enough "this month."

Editorial—Just so-so.

"Airplane of the Future"—Good idea. Have an article in nearly every issue.

"Yellow Air Peril"—Very good.

This is the kind of story you need. Has a good, exciting plot and *does not make science the whole point of the story.*

"Ark of the Covenant"—See criticism of "Yellow Air Peril."

"Air Terror"—Much better than "Islands in the Air." Hasn't exactly an original plot, but is thrillingly told.

"Flight in 1999"—Old "get-the-money-just-in-time-pay-off-the-mortgage" plot. Good attention to small details (Game of "Mathic," name system, etc.). Fairly interesting.

"Where Gravity Ends"—Good idea and maybe a good story could have been worked out, but nothing happens. The small "newspaper clipping" practically tells the entire story.

Why not leave out some parts of some letters you print? There are very many parts that are of interest to only you and the writer in a great deal of the letters sent in. If only parts were published, more letters could be used.

How about printing "Flying Death," a book, by Edwin Balmer? (E. Balmer is one half of the "Balmer, MacHarg" team, I believe). "Flying Death" is somewhat like "The Bloodless War," only much more developed.

Don't, PLEASE, put out an AIR WONDER QUARTERLY.

AIR WONDER STORIES gets better and better, every issue.

I think it would be well to cut down on "Latest Air News" dep't.

"Air Forum" is a good idea.

H. Bogg,
Oakland, Cal.

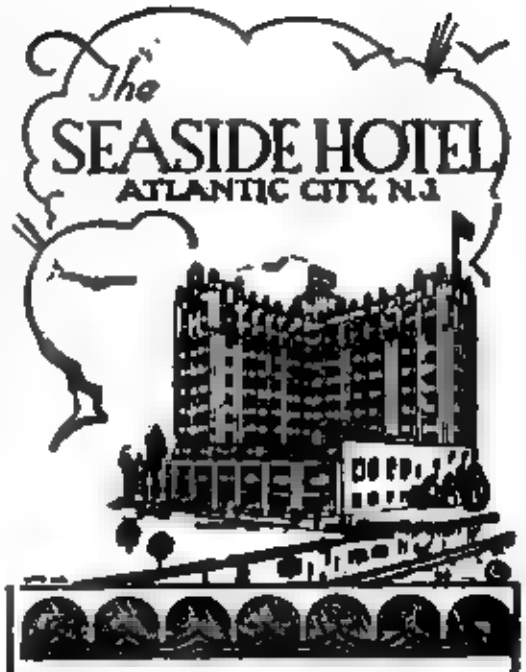
("The Flying Death" has not come to our attention before but we will investigate its possibilities. The careful analysis given here is appreciated. We agree that science should not be the entire basis of a story. The emotions, reactions and adventures of human beings will always hold a great interest for us. And after all the study of psychology is in itself a science, and where the motives of people are laid bare, a bit of science has been developed.—*Editor.*)

Another Case of Conversion

Editor, Air Wonder Stories:

Before your magazine came out I had been reading one very similar to it. Since I am only eleven I am not very well fit to criticize your magazine. "Flight in 1999" and the "Human

(Continued on Page 477)



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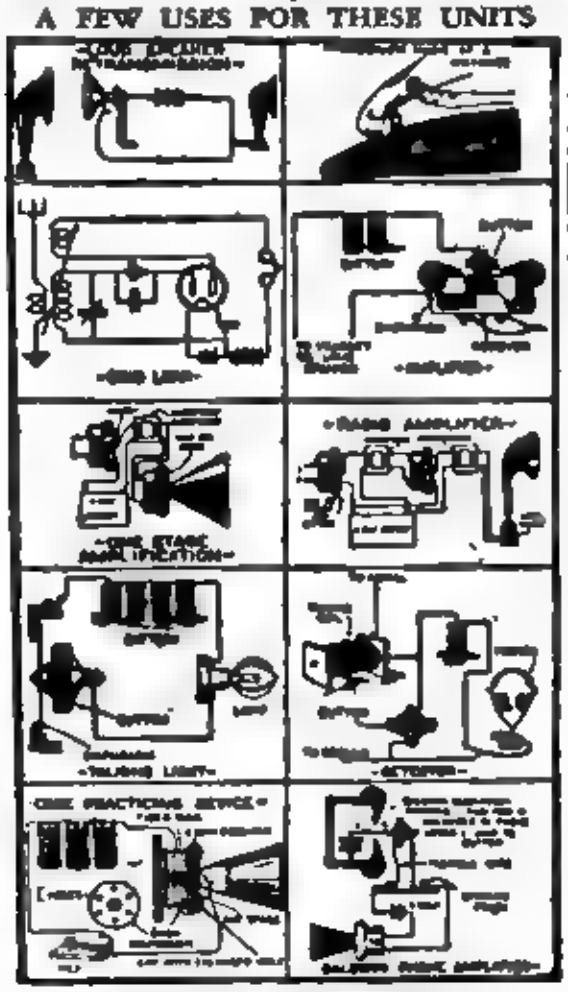

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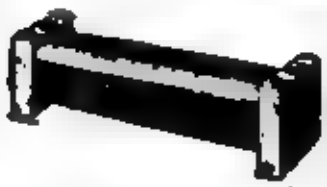

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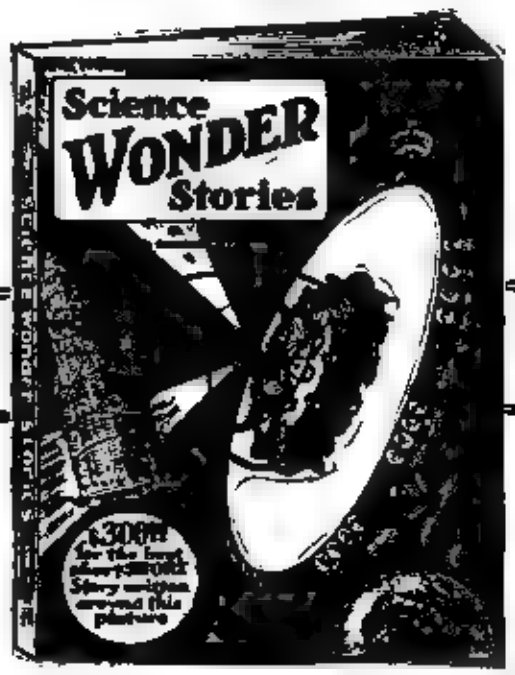

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THE READER AIRS HIS VIEWS

(*Continued from Page 477*)

Plane to Fly Backward

Editor, Air Wonder Stories:

Your magazine "Air Wonder Stories" sure is a "Wow."

I was away at camp for 3 weeks and couldn't get the August issue, and when I came back none of the stores had it. So I am sending to you for it.

I can't find any source of criticism of any of the stories in the magazine although I noticed in your September issue something wrong in the picture of the airship of the future. Question might be raised as to whether the plane was to fly backwards or forwards because the steam, escaping from the tips of the propeller, shows it to be turning backwards.

Well Mr. Gernsback I guess I had better sign off now because I have nothing more to say except that I want to compliment you on your swell magazine and wish you luck and success.

J. F. Alburger,
Merion, Pa.

(In the illustration the propellers are shown as rotating clockwise which we believe is the standard method of rotation to propel the plane forward through the air.—*Editor.*)

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"The Gravitational Deflector," by Harry D. Parker.

Do not miss the initial issue now on all newsstands.

Reinstating Faith

Editor, Air Wonder Stories:

So many times have I written to various magazines and so many times have I looked for a publication of my letters in vain, that I have began to lose faith in the magazines, so if you want to reinstate that lost faith you may do so by putting this into your column. Now, your serial, "The Ark of the Covenant" is probably the most interesting story I have ever read. More stories from Mr. MacClure's pen "The Beacon of Airport Seven" and "The Bloodless War" are also very good "Men With Wings" comes close upon the heels of Mr. MacClure's remarkable story.

I think that "Beyond Gravity" was the best story of your (or is it our?) August issue.

"The Yellow Air Peril" and "Flight in 1999" were excellent. Now for some "brickbats."

I haven't really enjoyed either of Mr. Morrow's stories and "Where Gravity Ends" was terrible—the science may be good but the story was terrible. In answer to Arthur Kauper's criticism of Paul's art I may say that the shadow of the tower nearest the top is not a shadow at all, but a reflection. Also with the varying wind currents it is not improbable that the wind cone should be blowing in the opposite direction of the smoke. Here's to a Quarterly.

Ronald J. Small,
New York City

(We really can't place the letters we have received from Mr. Small before. We want him to know however that we receive so many letters that it is possible to print only a fraction of them. We hope however this makes amends for past disappointments.—*Editor.*)

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BOOK REVIEW

THE ARCTIC RESCUE, by Captain Einar Lundborg, translated by Alma Louise Olson, 220 pages, illustrated, stiff cloth covers. Size 6 x 9½. Published by Viking Press, New York. Price $3.00.

Many stories, and some of them conflicting in one or more details, have come to the world from the wreck of the now notorious Nobile Expedition to the North Pole. Since the rescue of the crew of the *Italia* turned out to be an international matter, with four nations cooperating in the search for the missing men, the stories given to the world have varied somewhat according to the desire to have the efforts of one's own nationals put in a favorable light.

The present volume from the pen of the man who actually rescued Nobile, and was himself subsequently (in attempts to rescue others of the crew) stranded in the ice fields, should be received as authentic. Captain Lundborg writes with true Scandinavian restraint, feeling painfully at times the necessity of detailing the facts with the utmost accuracy.

For example he described, just as it happened, the now popularly-discussed selection of the first man taken back to land when Lundborg landed at the *Italia's* camp. Lundborg, himself for strategic (and possibly diplomatic) reasons wished to rescue Nobile, who was suffering from a broken leg. Nobile wished Ceccioni, who also suffered from a broken leg as well as other injuries, to go first and himself last. But Nobile allowed himself to be persuaded by the members of his party to go first, and he did.

One gets in this book an admirable insight into the vast preparations necessary for the rescue party. In the popular expositions of the work given by the newspapers, the spectacular elements connected with long flights, death, and heroism have thrown into the background how much the success of such expeditions depended on the careful scrutiny of supplies and the deciding which, of the limited number of things that could be taken, should go. Further we learn, perhaps for the first time, how much depended, too, on the picking of suitable landing spots in the treacherous ice and snow of those Arctic fields.

PRACTICAL FLIGHT TRAINING, by Lieutenant Barrett Studley, U. S. Navy. 435 pages, illustrated. Stiff cloth cover. Size 5½ x 8½. Published by Macmillan Company, New York. Price $5.00.

Lieutenant Studley as a navy aviation instructor is undoubtedly competent to write on practical aviation training for the student. His present book is designed chiefly as a handbook for the beginner.

It is written with an eye for thoroughness, and it achieves it, and achieves at the same time a remarkable clarity of thought. The subject of aviation is finely divided into a study of the essentials of aviation training, elementary flying which includes the standard maneuvers in the air, advanced flying which includes such things as acrobatics, precision landing on power, cross-country flying, aerial navigation, formation flying, night flying etc. Drawing from his experience, Lieutenant Studley also includes several chapters on the work of the instructor and what the flight school should do.

Interesting is Lieutenant Studley's analysis of the subject of personal qualifications necessary to make the aviator. "Flying is an art," he says tersely, "and without natural ability it is useless to attempt it." Alertness is vital. The pilot must always be looking around at engine instruments, obstructions, approaching planes, wind. He must also constantly have the feel of the plane so that what the instruments do not tell him about its performance he can judge. "Any tendency toward absentmindedness must be left on the ground."

These are no doubt cruel facts that many aspiring aviators, eager to enter an exciting profession, do not realize. But whereas a momentary lack of attention in a motor car may mean a bent fender or a blowout, in the air it may mean a loss of limb or life. And this will be increasingly true, for with the increasing tendency to use the air, the skies will be filled with planes darting about at speeds from 100 to 300 miles an hour.

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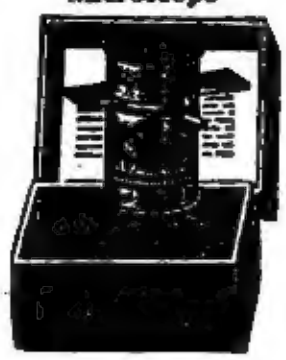
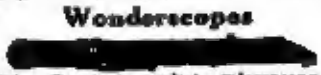
Microscope



A real high-powered imported pocket microscope for instruction and laboratory work. Has adjustable and automatic lens for correct focusing. Comes with 1 prepared subject and three specimen glass slides. Entirely made of lacquered brass. Packed in a neat leatherette box. Magnifies 40 diameters.

No. 8317 Microscope Price $1.40

Wonderscopes



NEW! Greatest pocket microscope invented. Looks like a fountain pen and ACTUALLY MAGNIFIES 25 TIMES. Hair looks as big as a rope. See the pores in your skin. Has slide adjustable lens. For home, laboratory or shop. Full black enamel with clip. Its size measures 5"x⅝". Must be seen to be appreciated.

8303. Wonderscope A— Prepaid 95c

8052. Wonderscope B—Same as above but adjustable to the amount of light available. Prepaid $1.35

Luminous Paint

Make your own luminous articles. Paint watch and clock hands, electric light switches, push buttons, keyholes, house numbers, etc. 1,000 uses. Articles treated stand out brilliantly in dark. The darker the room, the more brilliancy.

No. 8300 Luminous Paint Prepaid 25c

No. 8300-A Large Size $1.00

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No. 8310 Noseblower Prepaid 10c

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No. 8500. Rolled Gold Opera Glass Charm. Prepaid 75c

Microscopes

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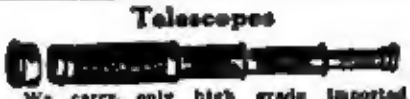
No. 8545. Microscope. Magnifies 50 diameters. Prepaid $3.75

No. 8546. Microscope. Magnifies 70 diameters. Prepaid $5.50

No. 8547. Microscope. Magnifies 90 diameters. Prepaid $6.75

Telescopes



We carry only high grade imported French telescopes. All came in gold brass lacquer. The most powerful telescopes made. No. 8650 is covered with black Morocco leather. Brings object nearer ten times. This number has also brass dust cap and automatic eyelide piece. Comes in imitation leather carrying case.

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No. 8649. Telescope. Three draw 12½". Prepaid $3.50

No. 8650. Special telescope 4 Sections. 13½" long. Prepaid $4.95

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No. 8509A Set of 25 Cartridges, by exp. collect .25

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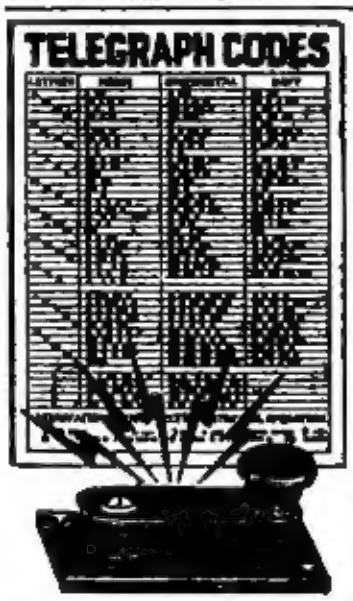

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No. 8525 Telegraph Set Prepaid 25c

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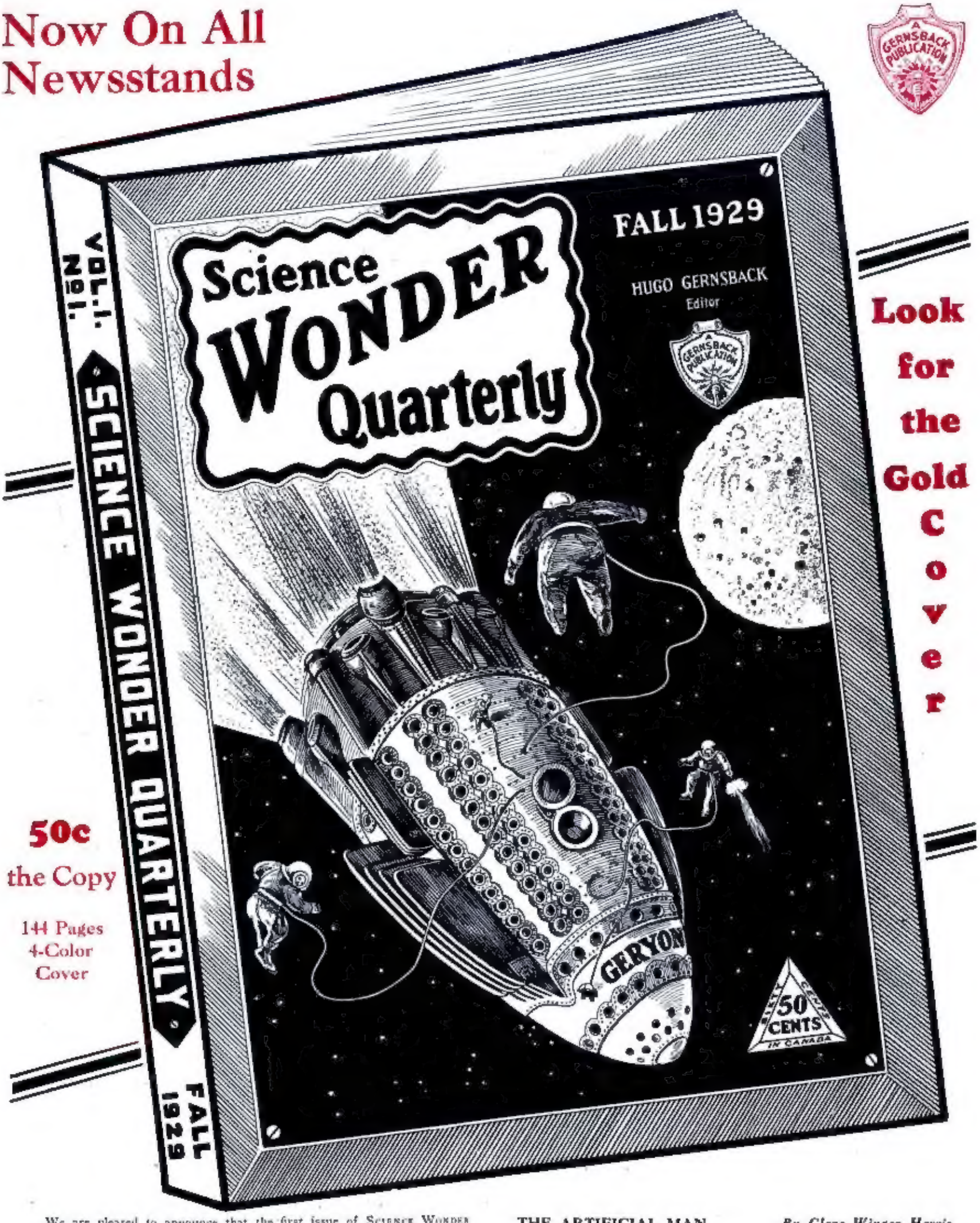

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